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CARCINOMA OF THE THYMUS, WITH MARKED PULMONARY OSTEO-ARTHROPATHY

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INTRODUCTION

THE literature concerning neoplasms of the thymus was reviewed, in 1932, by Crosby (8) who gave 103 references dealing with thymic tumors, among which were 122 cases of sarcoma and 36 cases of carcinoma. In the 30 papers dealing with the subject since that time, 44 cases have been recorded. The largest single series was that of Symmers (17) who reported 25 cases out of 17,000 autopsies at Bellevue Hospital, New York, the incidence being 0.14 per cent.

Of the 78 cases of sarcomas in Crosby's group, there were 45 males, 24 females, and 9 in which the sex was not stated. Forty-four cases of sarcoma had previously been reported by Rubaschow (14). The oldest was 86 years of age, and the youngest four and one-half. Of the carcinomas, there were 25 males, 10 females, and one in which the sex was not stated. The oldest was 72 years of age and one was reported at birth. Sarcomas usually occur before 40 years of age and carcinomas after 40. The sarcomas infiltrate the neighboring organs and tend to metastasize widely, usually *via* the blood stream. Carcinoma prefers the lymph channels for its extension, tends to infiltrate the surrounding structures more widely, and has a much higher incidence of central nervous system metastasis than sarcoma. Tables giving the incidence of metastasis in various organs are found in Crosby's article.

Classification of Thymic Tumors.—Symmers (17) recognized five types of tumors: perithelioma, lymphosarcoma, epithelioma from epithelial reticulum cells, spindle-cell sarcoma, and Hodgkin's tumor. Ewing's (10) classification is widely quoted: lymphosarcoma or thymoma, carcinoma arising from reticulum cells, and the rare spindle-cell or myxosarcoma. Andrus and Foot (5) divide the malignant thymomas into seven types: thymocytic or lymphatoid, large-celled or lymphoblastic, thymic reticulum-cell type, perithelial, granulomatous (Hodgkin's), epithelial or carcinomatous, and teratoid.

Since histologists do not agree on the origin of the reticulum and round cells of the thymus, the classification of its tumors is unsatisfactory. However, there are some tumors that are obviously carcinomas because of their squamous or glandular structures and others are easily identified as sarcomas. There remains a group about which there is much discussion.

Nomenclature.—The term "thymoma" is used, unfortunately, to mean different things by different authors, and even to mean different things by the same author, within a few paragraphs. It may mean any tumor of the thymus or only the round-

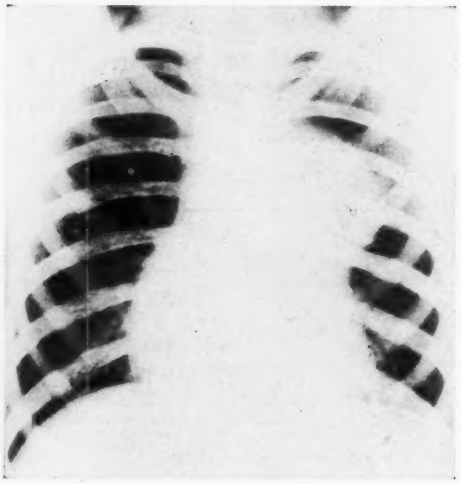

Fig. 1. Film of chest when patient was first seen. This appearance remained essentially unchanged after heavy irradiation.

celled tumors supposedly derived from thymocytes. The latter cells are of unknown origin; to some they are identical with lymphocytes, in which case the thymoma and the lymphosarcoma are identical, and to others they are distinct.

The diagnosis of reticulum-cell sarcoma also seems somewhat unsatisfactory since the histological and radiological criteria on which it is made are ambiguous. To one text-book author (Smith and Gault, 16) it means a radiosensitive tumor and to another (Boyd, 6) it means a radioresistant one. Some authorities say, for instance, that if a supposed lymphosarcoma does not melt away under moderate roentgen irradiation it belongs to the reticulum-cell sarcoma group. To one author it means simply a large-celled lymphosarcoma, to another it means a tumor in which the reticulum blends with the cytoplasm of the cells, and to others it is synonymous with carcinoma. Published illustrations of very different appearing tumors are labeled "reticulum-cell sarcoma." Different pathologists from the same school differ on the criteria on which the diagnosis is to be made. Symmers (18) writes, "If reticulum cells are derived from fibroblasts, the so-called reticulum-cell lymphosarcoma is not a lymphosarcoma because the unit of growth is not a member of the hematopoietic series. If reticulum cells are derived from lining epithelium, such as that of the sinuses of the lymph nodes, then again, the so-called reticulum-cell sarcoma is not a lymphosarcoma but reticulo-endothelioma. It is evident that the existence of the so-called reticulum-cell sarcoma has been hypothesized on premises which are not tenable, or, in other words, that the conception of a lymphosarcoma composed of reticulum cells is unsound."

In the present case, the diagnosis of reticulum-cell sarcoma was made on biopsy specimens even though the difficulty in differentiating it from carcinoma was admitted. When finally sufficient material was available, it was observed that although there was considerable reticulum present, it was more dense at the periphery of the clumps of cells and scanty or missing in the center.

Since roentgen irradiation is one of the most powerful weapons against certain of these tumors, the radiologist would like to know whether the tumor belongs to the general type of the radiosensitive lymphoma group or to the more radioresistant epithelial group. One would prefer then, as does Schmicke (15), the names *lymphoma* and *lymphosarcoma* for the benign and malignant ones of the former group, and *carcinoma* for the latter.

Epithelial structures forming Hassall's corpuscles may appear in any of the tumors, but their appearance in the extensions and metastases may be taken as evidence of the epithelial nature of the tumor. In this respect, carcinoma of the thymus resembles "lympho-epithelioma" of the pharynx, in which the primary tumor may have a comparatively scanty epithelial component and yet, in its metastases, may appear as an ordinary squamous-cell carcinoma. The lymphoid element need not be taken along in the metastasis.

The present case indicates many of the diagnostic difficulties which present themselves.

CASE REPORT

T. F., a 14-year-old boy, was well until March, 1938, when his ankles began to swell and he began to have many chills. He had lost 18 pounds in weight up to his hospital entry on May 17, in spite of the edema of extremities. Two weeks before entry there was a biopsy on the left axillary lymph node, reported lymphadenitis by this department. One week before entry there was a sharp, left-sided chest pain not increased by exertion or activity. No hemoptysis or cough. For the last month the patient had had to sleep on several pillows. With bed rest, the swelling of the feet and ankles had disappeared once, but promptly recurred with activity.

Physical Examination.—Temperature, 38.2° C.; respiration, 20; pulse, 90. The patient is a pale, sick, apprehensive boy, lying propped up in bed, showing obvious weight loss. The skin is dry, warm, and scaling. Finger and toe tips are definitely cyanotic, although the lips are of fair color. There is no lymphadenopathy. Moderate venous distention of the neck.

Fig. 2.

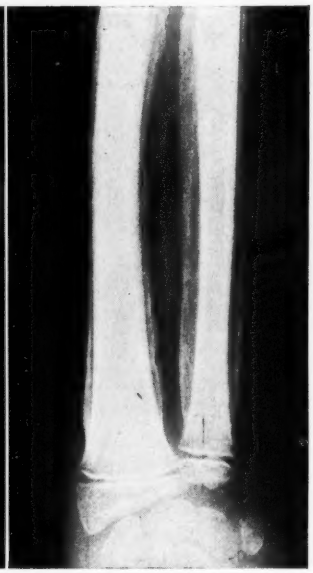

Fig. 3.

Fig. 2. Pulmonary osteo-arthropathy in the hands; the terminal phalanges are spared.

Fig. 3. Pulmonary osteo-arthropathy in forearms. This change involved all of the long bones.

Chest examination is negative except for distant breath sounds over the left anterior upper chest. The abdomen is negative. The extremities show striking clubbing of the fingers and toes, thickening of all the joints of the extremities, and a marked non-pitting edema of the hands and feet. There is extreme weakness of the upper extremities. The reflexes are normal and no pathological ones are present.

Laboratory Findings.—Red blood cell count, 3,500,000; hemoglobin, 64 per cent; 10,000 white cells with 80 per cent neutrophiles, and no abnormal cells. Urine and stool examinations are negative. Venous oxygen content, 14 volumes per cent; CO_2 combining power, 64 per cent; calcium, 8.0 mg. per cent; phosphorus, 3.1 mg. per cent; phosphatase activity (Rob-

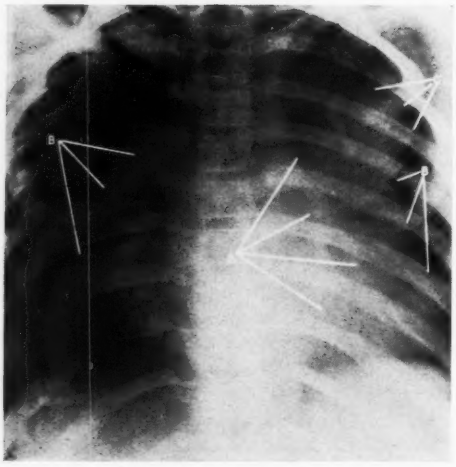

Fig. 4. *A*, Normal pulmonary artery is demonstrated. *B*, Heart borders. This appears wide because of the posterior projection at a short distance. *C*, Tumor.

erts), 18. Sedimentation rate, 30 mm. per hr. (Cutler). Tuberculin, 1:100, negative. Coccidioidin test, 0.1 c.c. of 1:10, negative. Skin and macroscopic agglutination tests for *B. abortus*, negative. Stomach washings negative for tubercle bacilli and fungi by guinea pig inoculation. Scrapings from the mouth showed monilia. Wassermann, negative. All these findings remained essentially constant except for a terminal rise in white blood cell count. EKG on entry: A-V conduction time, 0.18 second: unchanged a month later except T take-off slightly elevated above the iso-electric line in lead 3.

X-ray Examination (May 17, 1938).—There is a large round mass in the left side of the chest which is inseparable from the shadows of the great vessels (Fig. 1). It protrudes backward as well as forward and to the left. It hardly pulsates at all although the heart pulsates moderately.

Dr. Newell thought the shadow in the mediastinum might be tumor, most likely Hodgkin's, although he felt that cyst and dilatation of the pulmonary artery could not be excluded. He advised biopsy of a palpable gland in the left axilla. If this failed to give the diagnosis, he still wished a therapeutic trial of irradiation on the chance of its being Hodgkin's disease.

On May 19, 1938: Upper and lower extremities all show the changes of pulmonary osteo-arthropathy (Figs. 2 and 3).

Progress.—Bronchoscopy on May 20, 1938, revealed carina reddened, right bronchus clear; left bronchus reddened and shows pressure from behind. Biopsy taken from this area in hope that some tumor could be found. Biopsy report showed chronic bronchitis.

Irradiation.—On the presumptive diagnosis of mediastinal Hodgkin's disease, a course of rather light irradiation was undertaken as a therapeutic test. From May 18 to June 6, 1938, 130 kv., filtered to give half value layer 0.3 mm. Cu, 17 r/min. to a 16 cm. circular field centered on the upper mediastinum, was given, 50 r for the first three treatments and 100 r per day for the remainder to a total of 1,050 r (1,365 r skin dose with back-scatter). The mediastinal shadow remained unchanged. Heavy irradiation was, therefore, decided on. From June 7 to June 27, 1938, 350 kv., filtered to give a half value layer of 5.0 mm. Cu, 12 ma., 50 cm. distance, 15 r/min. in air, to a 15 × 15 cm. field, was given. Daily treatments totaling 1,400 r to the posterior chest, and 1,000 r to the anterior chest (20 per cent back-scatter to be added) were given.

At the end of this course of therapy there was still no change in the size of the mass in the chest. The right knee joint was needled and 30 c.c. of straw-colored fluid was withdrawn. This showed only a few pus cells, no ærobic or anærobic growth, and guinea pig inoculation was negative.

Visualization of Pulmonary Artery.—Since there was no response of the tumor to x-ray therapy, it now seemed impossible to decide with certainty between a radio-resistant neoplasm, a dermoid cyst, and a possible pulmonary aneurysm. In order to rule out the latter possibility, 30 c.c. of 35 per cent solution of diodrast was injected into the cubital vein within a space of two seconds. Films of the chest were taken immediately and at two-second

intervals. The normal pulmonary artery was clearly shown (Fig. 4). Films of the abdomen made a few minutes later showed a normal concentration of the medium in the pelves and ureters of the kidneys. Following this dose (about three times normal size and given as quickly as possible) there was an immediate choking reaction that lasted a matter of seconds and passed spontaneously, followed by an acute urticarial reaction which, too, lasted only a short time and subsided without specific therapy. There were no other ill effects.

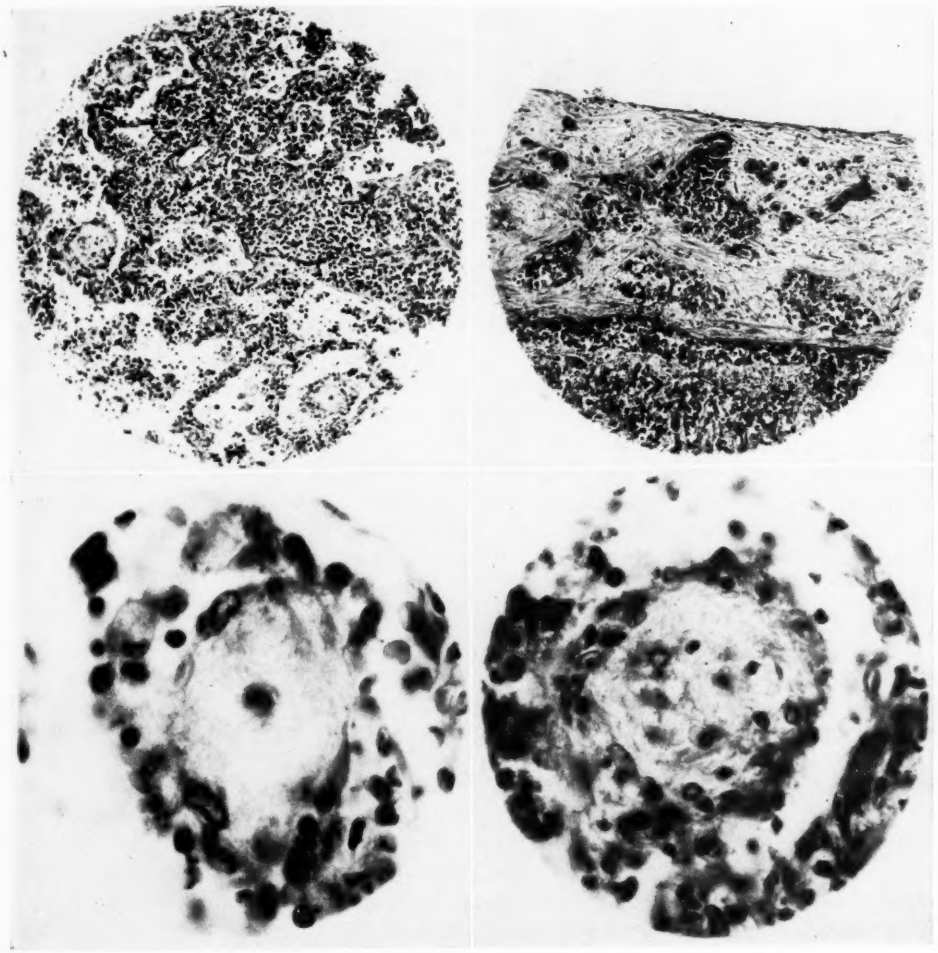

Fig. 5 (*upper left*). Metastatic tumor nodule in the lung. The histology is variable. In some regions the cells resemble lymphocytes crowded into dark masses or scattered in the stroma. In some places the cells are in large masses, with more or less central necrosis. Here the cells, variable in size, tend to be large, some with abundant acidophilic cytoplasm, and others with little cytoplasm.

Fig. 6 (*upper right*). Tumor infiltration in pleura; cells in sharply defined masses, resembling medullary carcinoma.

Fig. 7 (*lower left*). Area from the outer edge of the infiltration in the left lung. There are a half dozen of these spherical masses which closely mimic Hassall's corpuscles. There is acidophilic débris in concentric whorls, and a rim of large cells with nuclei parallel to the circumference.

Fig. 8 (*lower right*). Another area from the left lung in which the tumor mimics Hassall's corpuscles.

Diagnostic Pneumothorax Started.—On July 16, 1938, 75 c.c.; July 17, 1938, 250 c.c.; July 18, 1938, 425 c.c. of air was injected. It was hoped that the thoracoscope might be used for diagnosis, but the lung covered the tumor laterally, the mediastinum was shifted to the right, and the tumor was demonstrated to be anterior to the lung and separated from it.

Operations.—A left thoracotomy was performed on July 21, 1938. Through an anterior left parasternal incision, the left second, third, fourth, and fifth costal cartilages were removed. The pleura was opened laterally. A 5 cm. tumor was exposed beneath the third costal cartilage, intimately attached to the great vessels. Removal was impossible, so only a biopsy was taken. The incision was closed and the patient returned to bed in fair condition. Biopsy was reported: reticulum-cell type sarcoma of the thymus.

The patient developed considerable difficulty in breathing, post-operatively, and a thoracentesis, with the removal of 900 c.c. of air, was done with marked improvement. By July 28, 1938, the wound was healing nicely and there was spontaneous resorption of the air in the pleural cavity.

On Aug. 11, 1938, the patient was again taken to surgery for a second attempt at removal of the tumor. There had been considerable regeneration of the ribs since the previous exploration. The tumor had grown a great deal since the last operation so that now it extended across the midline. It was felt that only total pneumonectomy would have removed the tumor from the left. This was decided against and another biopsy was taken. The patient returned to the ward in poor condition. Biopsy report, sarcoma of the thymus, reticulum-cell type.

On Aug. 22, 1938, stomatitis, gingivitis, and glossitis of monilial origin developed. The patient expired Sept. 22, 1938.

Autopsy, Sept. 22, 1938 (by Dr. William Dock).—The manubrium is firmly embedded in a uniformly gray-pink tumor mass which surrounds the aorta, the basal 0.5 cm. of the great vessels, and invests the upper third of the pericardium. It is 4 cm. thick between the sternum and the pulmonary artery, and the main mediastinal mass is 8 cm. wide. It tapers out over the pericardial sac and into the hila of both lungs but does not extend behind the trachea or main bronchi. The great vessels are compressed but not invaded. Plaques of tumor are present in the left parietal pleura and along the intercostal vessels down to the diaphragm, which also shows a few nodules. The solid mass of tumor at the hilum joins the left upper lobe to the mediastinum. The mass infiltrates into the left upper lobe in streaks and cords which surround blood vessels. The outer and lower portion of this lobe is almost completely airless and contains a few tumor nodules. The left lower lobe and the right lung contain only a few tumor nodules, the largest of which is 2 cm. in diameter. In the mediastinum, on the right, there is a mass of tumor tissue which contains a multiloculated cyst 3 cm. in diameter. The infiltration on the right is limited to the hilum. There is no tumor below the diaphragm.

Summary of Histological Findings (Figs. 5, 6, 7, and 8).—On reviewing the original slides of the axillary lymph nodes, it is possible to identify the strands and sheets of "reticulum" cells which infiltrate next to the capsule in three or four places, and smaller groups of cells in the nodes as the same cells as those found in the tumor. They are larger, have larger nucleoli, and paler nuclear material than reticulum cells usually have. The nodes have reacted to this invasion as to an infection, so that the follicular outlines are lost or are barely discernible even in parts of the nodes where tumor cells are rare. The first substernal biopsy, although it has two degenerated Hassall's corpuscles, has no other structural characteristics of carcinoma. In the second biopsy from the chest, there are alveolar cell masses free of reticulum, although reticulum is abundant throughout most of the tumor. This

reticulum seems derived from the stroma, the fibers being heaviest on the periphery of the cell clumps. At autopsy most of the tumor is unlike sarcoma in that the cells have rather abundant cytoplasm and giant nuclei are not uncommon. Multinucleated cells occur, but mitoses are rare. The giant nuclei have sharp boundaries and a fine dark network, together with large nucleoli, but they are almost unstained, except for these features. The large cell masses are free of reticulum, but polymorphonuclear leukocytes are common in those with cellular débris.

Sections of the fibula and metacarpal show a normal marrow cavity in the central two-thirds of the shaft. This is surrounded by dense cortex, perhaps a little thinner than normal, then another concentric ring of marrow, largely fatty and fibrous with rare bone spicules, and then another concentric ring of bone which is fairly dense but has deep pits containing fibrous tissue dipping into it from a thick periosteum (Figs. 9, 10, and 11).

Fig. 9. X-ray of metacarpal, rib, and upper end of fibula. The inner marrow cavity, the cortex, the outer concentric marrow cavity, and new dense bone are well shown.

Discussion of the Tumor.—The difficulty in making an accurate diagnosis on this case is easily appreciated when three biopsies failed to reveal its true nature. It was only after re-examination of the specimens with the autopsy material at hand that it was realized that tumor was present, even in the axillary node first seen. The tumor cells closely mimicked reticulum cells, and the reaction of the rest of the node was as to an infection. Only two structures faintly resembling

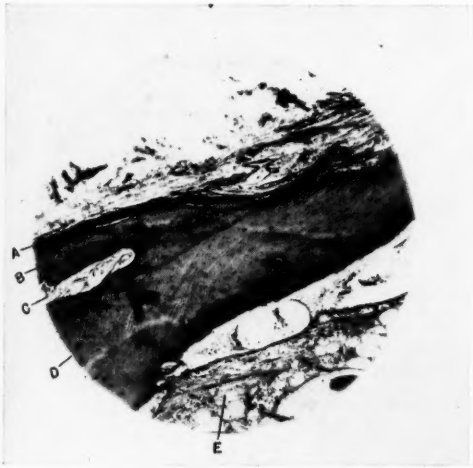

Fig. 10.

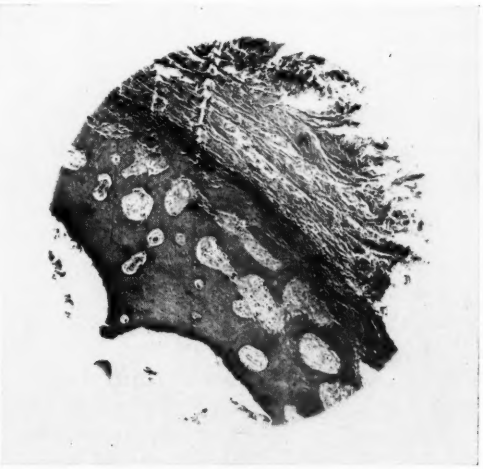

Fig. 11.

Fig. 10. Longitudinal section of metacarpal showing osteo-arthropathy. *A*, Dense periosteum. *B*, Concentric layer of dense new bone. *C*, Fibrous marrow. *D*, Cortex. *E*, Central marrow. The new bone is subperiosteal and laid down on the old cortex with fibrous, fatty marrow between the two.

Fig. 11. Cross-section of rib showing new fibrous tissue dipping deeply into the cortex from the periosteum.

Hassall's corpuscles were found in the material removed at operation and they were so atypical as not to be convincing proof of the epithelial nature of the tumor. However, at autopsy, the evidence of the carcinomatous nature of the tumor was quite convincing. The observed resistance to x-ray treatment is in keeping with the diagnosis of carcinoma.

It seems reasonable to make irradiation the first therapeutic approach to mediastinal tumors. It is relatively safe and simple, while biopsy is hazardous. If the masses melt under relatively small doses, the diagnosis of Hodgkin's disease or lymphosarcoma is justified. Operation is not made more difficult by the previous therapeutic test of irradiation.

It is interesting to note that there was neither clinical nor pathological evidence of myasthenia gravis in this case. Half the cases of myasthenia gravis are associated with some thymic abnormality. Of these, 30 per cent show only a hyperplasia, while 20 per cent are accompanied by malignant tumors, of which lymphosarcoma, perithelioma, and epithelioma have been reported.

Discussion of the Osteo-arthropathy.—I could find no reported case in which pulmonary osteo-arthropathy occurred in this type of tumor, although its development in other mediastinal carcinomas is not rare. A great deal has been written on the subject, "yet in the 44 years that have elapsed since Bamberger first described it, little of real significance has been added to our knowledge of the condition" (Hodges, 1938, 11). Locke (13), Högler (12), and Crump (9) gave excellent reviews of the subject. Crump recognized three components of the disease: a generalized periostitis, clubbed fingers, and a toxic arthritis. Högler recognized three fundamental processes commonly preceding the development of the condition: chronic purulent disease of the chest and lungs, malignant tumors, primary in the lung or mediastinum or in which metastases had occurred in the chest, and biliary cirrhosis. Conditions causing unilateral clubbed fingers, presumably due to pressure on the nerves of one arm, such as aneurysm, and in one case, dislocation of the shoulder, produced only thickening of the soft tissues. The clubbed fingers that occur with heart failure also affect only the soft tissues. However, Locke states that the two conditions should be regarded as identical and that the clubbed fingers are simply an early stage of the true pulmonary osteo-arthropathy. The etiology of the condition is unknown and hypotheses concerning its cause are many. Toxic circulating material, stasis, rheumatic type of infection, tuberculosis, scleroderma, arsenic and iron poisoning, and syphilis have all been suggested. None completely explains all cases. Most of the cases are associated with a rather severe arthritis. As in this case, culture of the fluid from the joints is sterile. Grossly, there is a generalized periostitis affecting all the long bones; it is most severe on the proximal phalanges, metatarsals, metacarpals, and the long bones of the extremities. The forearm and leg are more affected than the upper arm and thigh. The distal phalanges are not affected. In extremely severe cases, even the flat and irregular bones are involved. Histologically, there is first a round-cell infiltration of the periosteum, later a primary layer of dense bone is laid down concentrically, and, subsequently, this becomes porous and the holes are filled with a fibrous marrow.

Discussion of Arteriography.—Arteriography was first carried out in 1923, and was limited mostly to extremities. About 1935, a group in France (1, 2, 3, 4) first demonstrated the pulmonary arterial tree, in the living, by inserting a ureteral catheter through the basilic vein of the left arm into the right heart and injecting a solution of sodium iodide. Apparently the procedure was without danger. It is only recently that injection of contrast medium into the veins of the arm with a syringe has been practised successfully. At a recent meeting of the American Medical Association, Dr. G. P. Robb and Dr. I. Steinberg (19) described their technic.

Twenty c.c. of 70 per cent solution of diodrast is placed in a 50 c.c. Luer syringe; a large needle is attached and is inserted into one of the cubital veins. Twenty c.c. of blood is drawn into the syringe, where the blood floats on the diodrast; the whole is quickly injected, the diodrast floating in first, followed by the blood. Films are taken immediately. These authors say there is no great danger. In our own case there was an immediate choking reaction which passed off very quickly. Later there was an urticarial reaction with quick subsidence. Contiades and others (7) have discussed the dangers of the procedure.

SUMMARY

1. A case of carcinoma of the thymus is reported, in which marked pulmonary osteo-arthropathy was a conspicuous feature.

2. A discussion of the difficulties in the diagnosis of thymic neoplasms is presented.

3. A discussion of pulmonary osteo-arthropathy and pulmonary artery visualization in the living is appended.

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REFERENCES

(1) AMEUILLE, P., and HINAULT, V.: Arch. d'electric. med., **45,** 136–142, May, 1937.

(2) AMEUILLE, P., RONNEAUX, G., HINAULT, V., and DESGREZ, H.: Bull. et mém. Soc. de radiol. méd. de France, **25,** 118–122, February, 1937.

(3) Idem: Jour. de radiol. et d'électrol., **22,** 97–102, March, 1938.

(4) Idem: Bull. et mém. Soc. méd. d. hôp. de Paris, **52,** 729–739, May 18, 1936.

(5) ANDRUS, W. DE W., and FOOT, N. C.: Jour. Thoracic Surg., **6,** 648–659, August, 1937.

(6) BOYD, WILLIAM: Textbook of Pathology, second edition, p. 811. Lea and Febiger, Philadelphia, 1938.

(7) CONTIADES, J., UNGAR, G., NAULLEAU, J.: Presse méd., **43,** 1630–1634, Oct. 19, 1935.

(8) CROSBY, E. H.: Am. Jour. Cancer, **16,** 461–486, May, 1932.

(9) CRUMP, C.: Virchow's Arch. f. path. Anat., **271,** 467–511, 1929.

(10) EWING, JAMES: Neoplastic Diseases, third edition, p. 971.

(11) HODGES, PHEMISTER, and BRUNSCHWIG: Diseases of Bones and Joints, p. 126.

(12) HÖGLER, F.: Wien. Arch. f. inn. Med., **1** and **2,** 35, 1920.

(13) LOCKE, E. A.: Arch. Int. Med., **15,** 659, 1915.

(14) RUBASCHOW: Virchow's Arch. f. path. Anat., **206,** 141, 1911.

(15) SCHMICKE, A., HENKE, and LUBARSCH: Handbuch der Speziellen path., Anat., und Hist., **8,** 804.

(16) SMITH and GAULT: Essentials of Pathology, p. 297.

(17) SYMMERS, D.: Ann. Surg., **95,** 544–572, April, 1932.

(18) Idem: Arch. Path., **26,** 603–647, September, 1938.

(19) ROBB, G. P. and STEINBERG, I.: Am. Jour. Roentgenol. and Rad. Ther., **41,** 1–17, January, 1939.

ADDITIONAL BIBLIOGRAPHY

Thymic Tumors

1. ALAJOUANINE, T., HORNET, T., THUREL, R., and ANDRÉ, R.: Rev. neurol., **65,** 552–559, March, 1936.

2. BARKER, L. F.: Ann. Int. Med., **5,** 1113–1122, March, 1932.

3. BETTMAN, R. B.: S. Clin. North America, **12,** 1265–1270, October, 1932.

4. BOSANQUET, W. C., and LLOYD, W. E.: Lancet, **2,** 6–9, July 4, 1931.

5. BREM, J., and WECHSLER, H. F.: Arch. Int. Med., **54,** 901–915, December, 1934.

6. Cabot Case 21, 412: New England Med. Jour., **213,** 726, Oct. 10, 1935.

7. DECKER, H. R.: Jour. Thoracic Surg., **4,** 445–459, June, 1935.

8. ERCKLENTZ, B. W.: Klin. Wchnschr., **15,** 1393–1397, Sept. 26, 1936.

9. EVANS, R. G. P.: British Med. Jour., **1,** 775–778, April 9, 1938.

10. FISCHER, J. A.: Jour. Am. Inst. Homeop., **29,** 738–740, December, 1936.

11. GOLD, E.: Wien. klin. Wchnschr., **48,** 694–698, May 18, 1935.

12. HANDI, H., and HALLIS: Virchow's Arch. f. path. Anat., **284,** 231, 1932.

13. HASHIGUCHI, M.: Nagasaki Igakkwai Zassi, **14,** 1468, Sept. 25, 1936.

14. KASILOVA, A. I.: Russk. klin., **14,** 445, 1930.

15. LESLIE, M., and BELL W. S.: British Med. Jour., **2,** 1,006, 1,007, Dec. 3, 1932.

16. LIÈVRE, J. A.: Presse méd., **44,** 991, 992, June 10–17, 1936.

17. LOMAKIN, P. F., and SULIMOVSKAYA, N. A.: Varch. delo, **20,** 43–46, 1938.

18. MARGOLIS, H. M.: Am. Jour. Cancer (supp.), **15,** 2106–2142, July, 1931.

19. NISBET, B. R.: British Med. Jour., **2,** 403, Aug. 27, 1932.

20. NORRIS, E. H.: Am. Jour. Cancer, **27,** 421, 1933.

21. Idem: Am. Jour. Cancer, **30,** 308–317, June, 1937.

22. OBIDITSCH, R. A.: Virchow's Arch. f. path. Anat., **300,** 319–341, 1937.

23. PADILLA, T., and COSSIO, P., JR.: Semana méd., **1,** 1459–1470, May 28, 1931.

24. PEER, G. F., and FARINACCI, C. J.: Mil. Surgeon, **82,** 350–355, April, 1938.

25. SCHMIDT, H. G.: Röntgenpraxis, **9,** 411, 412, June, 1937.

26. SODA, K., and YOSHIDA, S.: Nagasaki Igakkwai Zassi, **15,** 2590, 2591, Dec. 25, 1937.

27. STRUTHERS, R. R.: Canad. Med. Assn. Jour., **26,** 68–70, January, 1932.

Osteo-arthropathy

28. BAMBERGER, E.: Bronchiestasie und Veräu-

derungeinzelner Röhrenknochen. Wien. klin. Wchnschr., **2,** 226, March 14, 1889.
29. Idem: Ztschr. f. klin. Med., **18,** 193, 1891.
30. Dale, T.: Acta radiol., **11,** 537–545, 1930.
31. East, T.: Proc. Royal Soc. Med., **26,** 272, 273, January, 1933.
32. Fränkel, E.: Fortschr. a. d. Geb. d. Röntgenstrahlen, **25,** 1918.
33. Freund, E. (Los Angeles): Am. Jour. Roentgenol. and Rad. Ther., **39,** 216–227, February, 1938.
34. Hasbrouck, E. M.: N. Y. Med. Jour., **67,** 665, 1896.
35. Kühne, K., and Gerstel, G.: Fortschr. a. d. Geb. d. Röntgenstrahlen, **46,** 662–670, December, 1932.
36. Marie, P.: Rev. de med., **6,** 297, 1886.
37. Idem: Rev. de med., **10,** 1, 1890.
38. Odessky, J. N., and Shirshnev, P. A.: Radiology, **30,** 250–254, February, 1938.
40. Penitschka, W.: Beitr. z. klin. Chir., **167,** 75–109, 1938.
41. Shaw, A. B., and Cooper, R. A.: Lancet, **1,** 880, 1907.
42. Thornburn, W.: British Med. Jour., **1,** 1155, 1893.
43. Weber, F. P.: Proc. Royal Soc. Med., **2,** 187, 1908.

Arteriography

44. Bazy, L., Reboul, H., Racine, M.: Bull. et mém. Soc. nat. de chir., **61,** 198–202, Feb. 16, 1935.
45. Berczeller, A., and Kugler, H.: Arch. f. klin. Chir., **190,** 810–815, 1937.
46. Beutel, A., and Klein, O.: Med. Klin., **32,** 899–902, July 3, 1936.
47. Bird, C. E.: Jour. Am. Med. Assn., **109,** 1626–1628, Nov. 13, 1937.
48. Bordoni-Possic, C., Palma, E. C., and Estable, J. J.: Arch. urng. de med., cir. y especialid., **8,** 161–178, March, 1936.
49. Bosco, J. J., Fierro, L. L., and Rosales, E. A.: Rev. méd. del Rosario, **28,** 68–82, January, 1938.
50. de Carvalho, L., and Rocheta, J.: Presse méd., **42,** 2057–2060, Dec. 22, 1934.
51. Charbonnel: Bull. et mém. Soc. de chir. de Bordeaux et du Sud-Oest, p. 134, 1932.
52. Conte, E., and Costa, A.: Fortschr. a. d. Geb. d. Röntgenstrahlen, **47,** 510–517, May, 1933.
53. Idem: Radiol. med., **20,** 1301–1314, October, 1933.
54. Idem: Radiology, **21,** 461–465, November, 1933.
55. Davies, H. W.: Med. Press, **196,** 487–490, June 1, 1938.
56. Idem: Bull. et mém. Soc. Nat. de chir., **61,** 187, Feb. 6, 1935.
57. Edwards, E. A.: New England Jour. Med., **209,** 1337, 1933.
58. Fuchs, A. W.: Radiog. and Clin. Photog., **13,** 10, 11, April, 1937.
59. Garraud, R.: Paris méd., **2,** 114–120, Aug. 7, 1937.
60. Hinault, V., and Desgrez, H.: Rev. de la tuberc., **2,** 936–943, October, 1936.
61. Hinault, V.: Jour. de méd. de Paris, **57,** 842–844, Nov. 11, 1937.
62. Vallery-Radot, Pasteur, Ledoux-Lebard, and Hamburger, J.: Progrès méd., pp. 945–949, June 6, 1936.
63. Ravina, A.: Progrès méd., pp. 1701–1705, Nov. 3, 1934.
64. Ravina, A., Cottenot, P., Sourice, A., and Lesauce: Bull. et mém. Soc. méd. d. hôp. de Paris, **52,** 770–772, May 18, 1936.
65. Reboul, H.: Masson & Cie, Paris, 1935.
66. Rencz, A.: Fortschr. a. d. Geb. d. Röntgenstrahlen, **54,** 404–410, October, 1936.
67. Spehl, G.: Jour. de chir. et ann. Soc. belge de chir., **34–32,** 252–256, May, 1935.
68. Zehnder, M.: Zentralbl. f. Neurochir., **2,** 281–283, January, 1938.

THE EVALUATION OF ROENTGEN IRRADIATION AS AN ADJUNCT IN THE TREATMENT OF ACUTE OTITIS MEDIA[1]

A PRELIMINARY REPORT

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IN many acute inflammatory conditions, roentgen therapy is now recognized as a valuable therapeutic aid, particularly in pyogenic infections. Such recognition is well founded upon experimental and clinical bases. This preliminary study deals with a series of 30 cases of acute otitis media treated with encouraging results by roentgen therapy as an adjunct to the routine care of such cases.

Numerous articles have appeared in recent literature discussing the use of roentgen therapy in the treatment of furunculosis, carbuncles, parotitis, cellulitis, erysipelas, gas gangrene, unresolved pneumonia, and even acute lobar pneumonia. However, comparatively few papers have appeared concerning its use in nfections in the field of otology, although important contributions have been made by Granger (2), Schillinger (3 and 4), Crain (5), Cherniak and Gorodetzky (6) in the treatment of mastoiditis; Lucinian (9) on the treatment of otitis media and mastoid tis; Butler and Woolley (7), and Rathbone (8) on the treatment of certain types of paranasal sinusitis.

The rationale for the use of roentgen therapy in acute otitis media is the same as that for other pyogenic infections. Desjardins (1 and 10) has pointed out a factor which is common to all infections, namely, leukocytic infiltration. He believes that the variation in response to different infections may be due to the degree of this infiltration; that the greater the amount of infiltration, the quicker and more likely a favorable response to radiation therapy. Among others, Warthin (11) has demonstrated experimentally the extreme sensitivity of leukocytes, especially lymphocytes to roentgen irradiation. He noted lymphocytic disintegration within 14 minutes after the exposure. With the destruction of the leukocytes, there is probably an immediate release of antibodies and ferments contained within these cells. This liberation makes these substances more easily available for defense at the site of the local lesion. Certainly in therapeutic doses, roentgen rays have no direct bactericidal effect. A secondary increase in phagocytosis seems well established on experimental grounds (12). A decrease in the swelling and the congestion at the site of the local lesions, following radiation therapy, relieves pain and facilitates drainage. A temporary increase in the swelling and in the pain not infrequently follows roentgen-ray therapy in furuncles and carbuncles. This has not been experienced by us in the treatment of acute otitis media; however, it seems possible that this could also occur in this disease. The character of the discharge in otitis media either remains thin or becomes so, following radiation. This results in adequate drainage of the middle ear cavity. With the reduction of congestion, the eustachian tube tends to be more patent, thus adding to the patient's comfort. Occasionally, drainage from the middle ear is established by this channel. Several patients in the treated group derived such benefit.

In view of the striking improvement brought about in certain cases by the very small doses of radiation, the treat-

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ment may be recommended as a conservative and safe procedure in experienced hands. The dosage (100 r) should cause no skin damage and may be repeated several times without risk to the skin or nearby structures. Its use does not interfere with subsequent operative or other procedures in any way.

The material has been classified into two major groups: a group of 30 cases treated with roentgen-ray therapy as an adjunct, and a control group of 26 cases treated in the usual manner. These were observed in the Strong Memorial and Rochester Municipal Hospitals during the latter half of 1937, and the first six months of 1938. It should be pointed out, that the separation of cases was dependent to a great extent upon the presence or absence of a bulging ear drum, for, in the latter case, myringotomy was preformed and on the issue of purulent material, the diagnosis of acute purulent otitis media was made. Otherwise, the case was classified as acute catarrhal otitis media. In the irradiated group are 15 cases of the latter, as well as 15 cases of acute purulent otitis media. The purulent cases are further divided into uncomplicated and complicated cases (mastoiditis, petrositis, etc.). Unfortunately, there are no catarrhal cases in the control group. All 26 control cases (diagnosed as acute purulent otitis media) were divided into uncomplicated and complicated groups.

For the purpose of this paper, the term "mastoiditis" has been empirically used when this complication of the otitis media was severe enough to suggest surgical interference. The cases showing simple inflammation of the mastoid, which accompanies the majority of severe cases, were classified as uncomplicated, acute, purulent otitis media.

All cases were handled in the customary manner, roentgen-ray therapy being added to the irradiated group as an adjunct to the routine care and treatment of such cases of acute otitis media. A myringotomy was performed on all middle-ear infections needing immediate drainage in this group. This was followed by roentgen-ray therapy. If seen early enough, the catarrhal group was treated with roentgen-ray therapy and observed. The cases have been analyzed with the following questions as objectives: (1) Does roentgen-ray therapy shorten the average course of the disease? (2) Does it lessen complications? (3) Is it of value in the treatment of complications?

Control Group.—The control group was picked at random from out-patient and house records over a period of 12 months, no attempt at selection being made, and no catarrhal cases being recorded. In this group the average duration of the disease on admission was 7.9 days (Chart I). The average duration of the symptoms after the institution of treatment was 29.6 days with an average total illness of 37.5 days. Spontaneous rupture of the tympanic membrane had occurred in 16 cases (over 60 per cent) at admission. The remaining 10 cases had a myringotomy performed while under observation. The 18 uncomplicated cases were seen on an average of 5.1 days after the onset of the symptoms, with an average duration of 22.1 days after the institution of treatment, making an average total duration of 27.2 days.

Among the 26 control cases, there were eight which were complicated by acute mastoiditis requiring operation. Five of these were admitted to the hospital at the first visit, with a well-developed mastoiditis. Three developed mastoiditis while under routine treatment. This may be contrasted with the mastoiditis cases in the irradiated group in which only one case out of four needed surgery after irradiation.

In 1937, and the first six months of 1938, there were 192 cases of acute, purulent otitis media serious enough to be admitted to the hospital for treatment. Of these, 55 (28.6 per cent) had surgical mastoid procedures for relief of symptoms, which corresponds quite closely to the incidence in the control group of 26 cases (30.8 per cent).

Roentgen-ray Therapy Group.—Of the 15 cases of *acute catarrhal otitis media*, myringotomy was necessary after irradiation in

only one instance. The average duration of the disease, before roentgen-ray therapy, was 2.1 days (Chart II). The duration of the disease after irradiation was 6.5 days, making an average total duration of 8.6 days. All of these cases might have done equally well without roentgen-ray therapy, but it was noted that the pain was materially decreased almost immediately after the treatment, and there were no resulting complications. In the absence of similar cases in the control group, no comparison is possible, although the short time of duration after treatment and the absence of complications in this group is suggestive.

It is interesting to note that the 15 *purulent cases* were of longer duration before coming for treatment as were also those in the control group, and 12 required myringotomy before the roentgen-ray therapy. There was spontaneous rupture of the tympanic membrane in three cases. The average duration of these 15 cases, after irradiation, was 21.5 days, with an average of 27.9 days, total duration. Of course it is impossible to say what the outcome of these cases would have been had they been seen at the very onset since myringotomy was necessary in only one out of the 15 cases treated in the catarrhal stage.

A careful study of Chart II reveals that 11 of the uncomplicated cases of purulent otitis media were seen on the average of 4 days after the onset of the disease. These had symptoms for an average duration of 17.6 days after roentgen-ray therapy, with a total average duration of the disease of 21.7 days. The other four cases were complicated with mastoiditis. Two cases developed definite mastoiditis before roentgen-ray therapy was instituted and made an uneventful recovery without surgical interference. One case was complicated by mastoid involvement while under observation after therapy, and surgical interference was necessary. The remaining case in this group perhaps should not have been included as mastoiditis, although surgery was considered because of the acuteness of the condition, and the inadequacy of the history of duration. Surgery was not necessary, however, after irradiation.

In most cases, the irradiation seemed to relieve the symptoms and shorten the course of the disease. The duration of the discharge was materially lessened over those cases not receiving roentgen-ray

CHART I.—ACUTE OTITIS MEDIA

Cases without Roentgen-ray Therapy

(Controls)

Classification	No. Cases	Average Duration before Admission	No. Treated 100 r Each	Average Duration after Admission	Average Total Duration of Disease	Percentage Purulent with Mastoiditis	Percentage Mastoidectomy	Remarks
Catarrhal	0							
Purulent including complications	26	7.9 days	0	29.6 days	37.5 days	14.3 per cent developed under treatment		4 bilateral 22 unilateral
Purulent without complications	18	5.1 days	0	22.1 days	27.2 days			
Purulent with advanced mastoiditis	8	14.1 days	0	46.6 days	61.0 days	30.8 per cent total	100 per cent	5 mastoiditis on admission 3 developed mastoiditis during treatment

therapy. The reduction of swelling of the parts involved improved the channels for drainage. The purulent material changed its character to that of a more watery consistency which also made better drainage possible.

RADIATION TECHNIC

One hundred r units were administered to the involved side (or to each side, if the condition was bilateral) with the following factors: 200 kv. (peak), 25 ma., 50 cm. target-skin distance, 0.485 mm. copper plus 1.0 mm. aluminum filtration. The size of the portal varied with the individual but was sufficiently large to include the ear, mastoid region, and posterior nasopharynx. Most of the patients required only one treatment. If the condition responded slowly, and immediate surgery was not indicated, a second treatment was given within from 48 to 72 hours. Of the 30 patients treated, 25 had one treatment each, and five had two treatments each (Chart II).

CASE HISTORIES

Case 1. F. M., a four-year-old boy, was admitted to the Municipal Hospital, on April 20, 1938, with the chief complaint of bilateral earache of five days' duration. This was unusually severe in the right ear. One week prior to admission, he contracted a mild upper respiratory infection. Five days previous to admission a myringotomy was performed on the left ear, followed shortly by a like procedure on the right ear. Examination revealed both ear drums adequately perforated. There was a moderate amount of pulsating purulent discharge in each external auditory canal but greater on the right. The right mastoid process was tender to pressure. Temperature on admission was 39.0° C., and the white blood cell count was 11,700. Roentgen examination of the mastoids revealed bilateral clouding, more marked on the right. There was no evidence of destruction of the mastoid cells. Cultures from the exudate taken from the external auditory canals showed *Micrococcus catarrhalis* and

CHART II.—ACUTE OTITIS MEDIA
Cases Treated with Roentgen Rays

Classification	No. Cases	Average Duration before Treatment	No. Treated 100 r Each	Average Total Duration after Treatment	Average Total Duration of Disease	Percentage Purulent with Mastoiditis	Percentage Mastoidectomy	Remarks
Catarrhal	15	2.1 days	14 1 treatment 1 2 treatments	6.5 days	8.6 days			1 myringotomy later 8 bilateral 7 unilateral
Purulent including complications	15	6.4 days	11 1 treatment 4 2 treatments	21.5 days	27.9 days	8.3 per cent developed under treatment		6 bilateral 9 unilateral
Purulent without complications	11	4.0 days	8 1 treatment 3 2 treatments	17.6 days	21.7 days			
Purulent with advanced mastoiditis	4	12.8 days	3 1 treatment 1 2 treatments	33.2 days	45.0 days	26.6 per cent total	25	1 early mastoid tenderness 2 mastoiditis before treatment, no operation 1 mastoiditis following treatment, with operation

Diphtheroid bacilli from the left, and *Pneumococcus*, Type I, from the right.

Despite routine treatment, the temperature continued to rise in the evening to 38.5° C.–39.8° C. for the next 48 hours. Forty-eight hours after admission, 100 r was applied to each ear and mastoid process. On the following day the highest recorded temperature was 37.5° C. Improvement was sufficiently great to permit discharge from the hospital, three days after admission, with referral to the clinic.

The patient's first admission to the clinic was on April 26, at which time the ears continued to drain moderately. There was no pain nor mastoid tenderness. On May 3, eleven days after irradiation, each ear had returned to normal and the child was discharged from the clinic.

The above case was that of a severe, bilateral, purulent otitis media in which there was no complicating mastoid involvement (see empirical classification) other than simple inflammatory changes such as are present in most cases of severe acute otitis media. Such satisfactory response to roentgen therapy did not occur with every patient treated, but serves to illustrate that an encouraging result can be obtained. The beneficial response within 24 hours was a "rather typical finding in most cases which responded to this type of therapy."

Case 2. H. B., a 65-year-old white, diabetic female, was admitted to the Rochester Municipal Hospital, on April 8, 1938, with a history of head cold and pain in the right ear for the two weeks prior to admission. This was associated with right-sided temporal headache, tinnitus, and deafness, and profuse nasal discharge. On admission, a slight amount of purulent material was draining out of the right external auditory canal. The right ear drum was tense and bulging. Both antra failed to transilluminate light and both nostrils were filled with purulent discharge. Roentgenograms of the mastoids at this time revealed beginning destruction of the bony cells. The urine showed 4 plus sugar; blood count, W.B.C., 15,500.

Under gas oxygen analgesia, a right myringotomy was performed. Only a small amount of thick purulent material was released, which, when cultured, showed the presence of *Pneumococcus*, Type III. The right ear did not drain well, and on April 15, 1938, the patient was given her first dose of irradiation. Immediately the pain subsided and the temperature, which had ranged about 38.5° C., dropped to normal. Drainage was still inadequate and a second dose of irradiation was administered on April 19, 1938, four days later. From then on the discharge became less stringy and more watery and the patient made an uneventful recovery, being discharged May 17, 1938, with a dry ear. The maxillary sinusitis was treated by irrigation every other day at first. Bilateral naso-antral windows were made after the third irrigation, due to the uncoöperation of the patient. The diabetes was controlled while the patient was in the hospital. The experience in this clinic with *Pneumococcus*, Type III, mastoid infections in elderly persons, with or without diabetes, has been that the majority of these cases has required surgery. This patient made a satisfactory recovery without surgical interference.

The effect of the radiation here is rather typical, although two doses were required to bring about the desired result. The following case reports are illustrative of inadequate dosage, the necessity for repeated doses in certain cases, and in others the failure to respond.

Case 3. T. M., a 23-year-old, white female, was admitted to the Rochester Municipal Hospital, on November 11, 1937, quite ill, with a history of an acute upper respiratory infection and bilateral earache, for 48 hours prior to admission. The temperature was 39.3 °C. The W. B. C. on admission was 6,250, with polymorphonuclears, 86 per cent, lymphocytes, 13 per cent, and monocytes, 1 per cent. Three days later the W. B. C. rose to 8,300, polymorphonuclears, 84 per cent, lymphocytes, 14 per cent, and monocytes, 2 per cent. Both drums were bulging, and

myringotomy released pus under pressure from which *Pneumococcus*, Type I, was cultured. Both antra were irrigated with return of foul-smelling purulent material. Her first dose of irradiation was administered on admission after myringotomy. The pain and discharge were unaffected, however, and her temperature remained elevated. Both antra were irrigated every other day. Five days after the first, a second dose of irradiation was administered. This was promptly followed by a fall in temperature and cessation of pain. The exquisite mastoid tenderness to pressure, present on admission, diminished. Progress henceforth was uneventful, and the patient was finally discharged Dec. 29, 1937, 49 days from the onset, with no discharge present and hearing normal. From the onset, because of the severity of the middle ear infection, the sinusitis, and general toxemia, it was felt that this patient would probably eventually develop a mastoid complication needing surgery.

In this case, the first dose of radiation was insufficient. The second dose should have been given much earlier; in fact, as soon as it was evident that the initial dose was insufficient. Usually this is apparent within 24 hours.

Case 4. L. R., a 54-year-old Italian male, was admitted to the Rochester Municipal Hospital, on Feb. 19, 1938, with the history of pain in the right ear for two days, following a mild upper respiratory infection. The right ear drum was bulging. The nasal sinuses were not involved. Temperature was normal; W. B. C. ranged from 9,800 to 10,000. A right myringotomy was performed shortly after admission with release of pus under pressure. Culture demonstrated the presence of *Staphylococcus albus hemolyticus*, and *Pneumococcus*, Type I. He continued to complain of pain behind the right ear radiating over the right eye and frontal region. The ear continued to drain, so that six days after myringotomy he was given a dose of irradiation. This did not help the pain or the discharge. Sulfanilamide was tried but the patient did not tolerate it well. Eventually, a simple right mastoidectomy was performed, and two distinct infected cell tracts were dissected well into the petrous portion of the temporal bone. Post-operatively, the patient developed erysipelas and had a most stormy convalescence. The ear continued to drain profusely and the eye pain persisted for several weeks. Eventually, the discharge abated, and on May 5, 1938, 78 days from the onset, the patient was discharged with a dry ear.

This case is unusual in itself, and the final outcome was fortunate for the patient for there were times during his illness when the prognosis was grave. This is the only case of purulent otitis media which had mastoidectomy. In view of the extensive complications, experience at this time was not sufficiently advanced to permit follow-up roentgen treatment. It has been found to be worth while in some cases (Case 2 and 3), and probably would have been of benefit in this case had it been applied before the mastoidectomy.

Case 5. L. D'B., an 11-year-old male, was admitted to the Rochester Municipal Hospital, on Feb. 8, 1938, with a history of purulent discharge from the right ear following spontaneous rupture of the drum. The present illness followed an acute upper respiratory infection. On examination, a profuse purulent discharge was observed, oozing from the right external auditory canal. There was marked swelling of the zygomatic and retro-auricular regions, pushing the ear out and giving the typical appearance of an acute zygomatic mastoiditis. Both nostrils were filled with purulent material, and transillumination was opaque for both antra. Bilateral antral irrigation was performed with a return of thick foul-smelling pus. The culture from the right ear canal showed *Streptococcus hemolyticus*, and *viridans*, and *Staphylococcus aureus*. Roentgen examination showed a diffuse clouding of the right mastoid with indications of beginning disintegration of the mastoid cells. Temperature on admission was 38.2° C.; W. B. C., 18,600; polymorphonuclears, 82 per cent; lymphocytes, 16 per cent; mono-

cytes, 2 per cent, and many stab cells reported.

The morning following admission, roentgen-ray therapy was administered and full therapeutic doses of sulfanilamide begun. The radiation brought about dramatic relief of pain and fever within 24 hours, which was before the effective sulfanilamide dosage level was reached. The antra were irrigated every other day and the ear wiped dry every two hours. Drainage was adequate. Progress was gratifying and the patient made an uneventful recovery in 14 days (15 days in the hospital). This boy was admitted on April 1, 1938, to the contagious division with scarlet fever complicated with mild acute purulent right otitis media (*Streptococcus hemolyticus* again), but no mastoid involvement or sinusitis. Sulfanilamide was again administered but no radiation was given. He made an uneventful recovery from both scarlet fever and the mild otitis media and was discharged on April 25, 1938.

The question immediately arises as to the individual benefits derived from the two types of therapy used in the first admission. Certainly the value of sulfanilamide in the treatment of infections with hemolytic streptococcus has been established beyond question. Since this patient needed all of our therapeutic resources on the first admission, the drug was not withheld in order to determine the outcome of roentgen therapy alone. On the second admission, the otitis media was a minor factor, so that radiation was not contemplated.

DISCUSSION

It is felt that in the small series of 30 cases presented here, roentgen-ray therapy has been of distinct value in aborting acute catarrhal otitis media, in shortening the course of acute purulent otitis media, and in lessening the incidence of surgery in those cases of acute purulent otitis media complicated by "surgical mastoid." There are many variables entering the picture, which make it both difficult and unwise to draw final conclusions concerning the results. Some of these are represented by the seasonal trends, the type and virulence of the infective agent, the duration of the infection when first seen, the treatment already instituted, and many other factors. Roentgen irradiation is not a panacea and may not be effective in every case. It will, however, be interesting to follow the reports of results of this therapeutic agent in the hands of others. We wish to emphasize that the clinical care of these patients should be in the hands of an otologist so that accepted methods of management can be properly carried out.

Five cases in the irradiated group were also treated with sulfanilamide. Two are described as No. 4 and No. 5. The three others seemed to have somewhat shorter courses than the controls, or those with sulfanilamide alone. These cases were so complicated by factors other than the otitis media that a critical analysis of the effectiveness of the combined treatments is impossible with such a small number of cases.

It is significant that the irradiation was not restricted to any one type or class of patients, since the groups included children and adults. The infectious agent involved likewise varied. Diabetes was not a contra-indication; in fact, in this type of case, radiation probably has much to offer, with little risk to the individual.

CONCLUSIONS

1. Thirty cases of acute otitis media treated with one or more doses of 100 r, and 26 unirradiated controls are analyzed in this preliminary report.

2. Even in these small doses, the irradiation seemed to be of distinct value in relieving the acute symptoms and in shortening the course of the disease. The average duration of the disease for the acute, purulent, uncomplicated cases was shortened six days, while that of the complicated cases was shortened 16 days. The clinical improvement when the treatment is effective is much more striking than these figures would indicate.

3. The incidence of surgery was apparently reduced.

4. The treatment seems to us a conservative method, since it does not interfere in any way with other forms of treatment if they become necessary, and it causes no permanent damage with this dosage. As with the other forms of treatment, better results are obtained in the early stages of the disease.

BIBLIOGRAPHY

(1) DESJARDINS, A. U.: Radiotherapy for Inflammatory Conditions. Jour. Am. Med. Assn., **96,** 401–408, Feb. 7, 1931.

(2) GRANGER, A.: The Treatment of Infections of the Mastoids of Infants when there is no Sign of Destruction Present, with Fractional Doses of Roentgen Rays. New Orleans Med. and Surg. Jour., **84,** 111–113, August, 1931.

(3) SCHILLINGER, R.: The Apparent Therapeutic Effects of the Roentgen Ray upon the Clinical Course of Acute Mastoiditis. RADIOLOGY, **18,** 763–776, April, 1932.

(4) Idem: Roentgenologic Aspects of Mastoiditis. Am. Jour. Roentgenol. and Rad. Ther., **39,** 193–201, February, 1938.

(5) CRAIN, C. F.: Roentgenologic Considerations in Infant Mastoiditis. Am. Jour. Roentgenol. and Rad. Ther., **38,** 592–601, October, 1937.

(6) CHERNIAK, W. P., and GORODETZKY, A. A.: Roentgen Therapy in Acute Mastoiditis. Jour. Laryng. and Otol., **49,** 675–678, October, 1934.

(7) BUTLER, F. E., and WOOLLEY, I. M.: Roentgen Therapy in Chronic Sinusitis. RADIOLOGY, **23,** 528–537, November, 1934.

(8) RATHBONE, R. R.: Roentgen Therapy of Chronic Sinusitis in Children. Am. Jour. Roentgenol. and Rad. Ther., **38,** 102–108, July, 1937.

(9) LUCINIAN, J. H.: Treatment of Otitis Media and Mastoiditis by the Roentgen Ray. Am. Jour. Roentgenol. and Rad. Ther., **36,** 946–953, December, 1936.

(10) DESJARDINS, A. U.: X-ray and Radium in the Treatment of Skin Diseases. MacKee, pp. 269–287. Lea and Febiger, Philadelphia, 1938.

(11) WARTHIN, A. S.: An Experimental Study of the Effects of Roentgen Rays upon the Blood-forming Organs, with Special Reference to the Treatment of Leukemia. International Clinics, **4,** 243–277, 1906.

(12) LILL, WULFF, B. I., and WARREN, S. L.: The Effect of Roentgen Radiation on Experimental *Staphylococcus* Infection in Dogs Simulating Furuncles or Boils. (Unpublished.)

THE ROENTGEN THERAPY OF CAREFULLY SELECTED SINUS INFECTIONS[1]

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THE increasing number of articles in the literature, especially those by Osmond, Manges, Rathbone, Woolley and Butler, and Waters and Firor, would certainly indicate that irradiation of some types of sinus infection has proven to be of definite therapeutic value.

As stated by one of the writers in a previous article, "For fifteen years a preliminary sinus film has been made on every patient sent in for chest examination, unless the pathology found seemed to be sufficient to explain the symptoms, and in all in which there was an increase in the lower lobe bronchovascular shadows. These films disclosed numerous unsuspected sinus infections. Many of these were cases of prominent physicians who had not in any way suspected these infections. Also many were in persons who had been treated by one or more rhinologists and were thought to be cured of the disease." These findings we believe prove: (1) that sinus disease is far more prevalent than is usually believed; (2) that on account of the meager symptoms its diagnosis is being overlooked in the majority of in-

[1] Presented before the Twenty-fourth Annual Meeting of the Radiological Society of North America, at Pittsburgh, Nov. 28–Dec. 2, 1938.

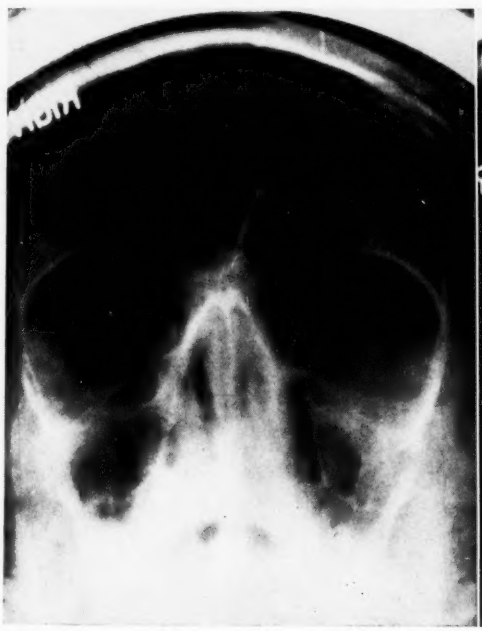

Fig. 1.

Fig. 2.

Fig. 1. Case 1, Group II, Sept. 17, 1936. B. P., white, male, 15 years of age. Film shows cloudiness of the frontals, marked cloudiness of the ethmoids, and thickened membrane in both antra. He was 20 pounds underweight, had a severe cough, headaches, swollen turbinates. Consistently under rhinologist's care for three years. Antra had been washed a number of times. Chest films show definite increase in the bronchovascular shadows to the lower lobes.

Fig. 2. (Oct. 27, 1936.) Film shows the sinuses almost clear. Following irradiation over the sinuses and chest the clinical symptoms disappeared. He gained weight and has been perfectly well since that time.

stances; (3) that the treatment is frequently inadequate and, (4) that in many instances no accurate method of checking the results of therapy is being routinely used.

An article in 1934, by Butler and Woolley, gives the results of some excellent experimental work. They "used twelve cats, in which the right frontal sinuses were punctured and infected with a virulent, hemolytic, streptococcic culture taken from a mastoid. All the cats showed definite evidence of infection within a few days and two died as a result of it." These investigators "determined upon three weeks as the duration under which infection would be kept alive and at the end of this time the remaining ten cats were sacrificed and divided into three groups."

Group I consisted of three cats which were irradiated over both frontal sinuses and given 800 r in air. Group II consisted of three cats which received 1,600 r over both frontals, the increased dose being given in order to determine if, and what, harmful results might occur from excessive radiation. Group III consisted of the four remaining cats which had been infected, but were not irradiated, and these were used as controls.

One cat from each group was killed at the end of one week, a second at the end of three weeks, and a third at the end of three months following irradiation. "The sinuses were exposed for gross inspection and the anterior portions of the skulls were then placed in Zenkerformal solution. After the membranes had hardened they were rolled, blocked, sectioned, and stained." Butler and Woolley then, "studied the effects of irradiation after a few days and accordingly another series of cats was prepared, as before, and killed 24, 48, and 72 hours following irradiation. The membranes were processed as above mentioned."

In summarizing the effect of irradiation on infected membranes of the sinuses they report as follows: "The effect of the x-ray treatment appears to be due primarily to

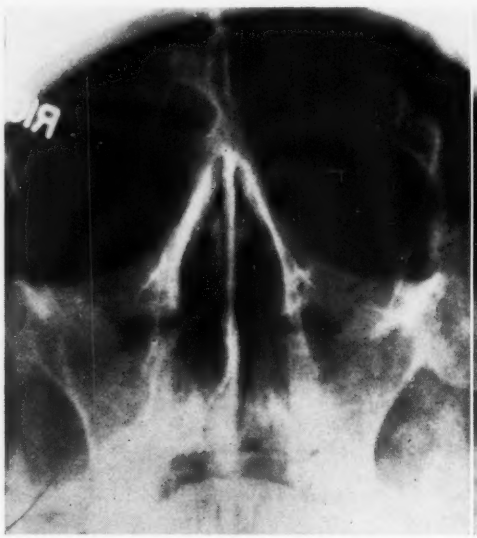

Fig. 3.

Fig. 4.

Fig. 3. Case 2, Group III, April 30, 1937. W. D. W., white, male, 40 years of age. Film was taken a few minutes after washing and shows marked cloudiness of the ethmoids, cloudy frontals, and the antra dense except for probably small air spaces. He had had sinus symptoms several years and been more or less constantly under the care of a rhinologist and the antra were washed a good many times.

Fig. 4. (May 18, 1937.) Film shows the sinuses almost clear. Clinically, the cough has almost entirely disappeared.

an early destruction of the lymphocytes in the infected membranes. From 48 to 72 hours after treatment of membranes, which had been infected for several weeks, there appears to be an increase in the number of macrophages. These are believed to come in response to substances released by the breaking down of the lymphocytes. These macrophages are seen to be laden with cellular débris and dead pigments. It is possible that they also engulf bacteria.

"The membrane becomes gradually reduced in thickness but retains numerous plasma cells, polymorphs, and some histocytes. After a week or more some fibrosis appears.

"There is no evidence of injury to the cilia, epithelium, or cellular elements other than the lymphocytes as the result of x-ray dosage. The fibrosis is considered a result of the inflammatory process and the increased number of histocytes immediately following the infection."

From these experiments, and from the well established value of irradiation in many other infections, as reported in many publications, it would certainly seem that we must admit there is justification for radiation treatment of sinusitis.

In a previous article, one of the writers gave a classification of sinus infections as to radiosensitivity; also, Waters and Firor, in a recent article, gave a similar one and our recent work has emphasized the value of this classification.

Group I. Acute sinusitis, in which there is good drainage, will generally clear up fairly quickly under the usual treatment of astringents, packings, and washings. In these cases we do not feel radia-

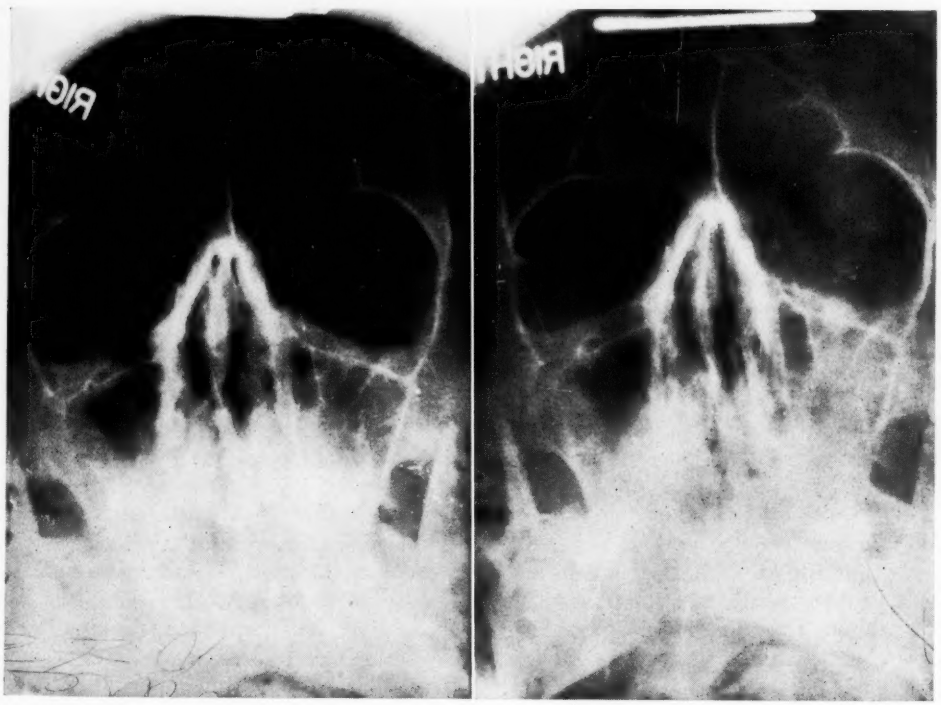

Fig. 5. Fig. 6.

Fig. 5. Case 3, Group III, Oct. 28, 1937. J. N. W., white, male, 42 years of age. Film shows the left antrum absolutely dense, so this was washed out. Had had sinus trouble for 15 years. Had been under several different rhinologists and had the antra washed many times.

Fig. 6. (Oct. 28, 1937.) Film was made immediately after washing. A small amount of pus was obtained. The patient was advised either to have radical operation on the two sides or to try x-ray.

tion is necessary unless it is used to hasten recovery.

Group II. This is the type of case that has, in our experience, responded best to irradiation. Such cases would be classified clinically as sub-acute or sub-chronic. Symptoms have been present for from several months to several years; usually there is a cough, a history of recurring colds, and the patient has been under the care of one or more rhinologists. Films show cloudy ethmoids with marked thickening of the membrane in the antra. Washings cause little or no change in the appearance of the antra, showing that there is little or no free pus. In many of these cases the bronchovascular shadows of the lower lobes are exaggerated.

Fig. 7. (Nov. 11, 1937.) This film was made only two weeks later. The patient went through the winter without any further treatment to the sinuses, the first winter in 15 years that he had been able to go longer than a few weeks without sinus treatment.

Group III. Symptoms have been present for several years, usually with hyperplastic sinusitis. There is marked cloudiness of the ethmoids, and marked thickening of the membrane in the antra. Group II gradually shades into Group III and an accurate history is essential in many instances for a proper classification. Usually, the longer the duration of the infection, the poorer the result. The majority of these cases have also responded to irradiation. In Groups II and III, with cough and increase in the bronchovascular shadows to the lower lobes, small doses are also applied over the lungs. This is, we believe, of definite benefit.

Group IV. Early, or reasonably early polypoid changes, especially in the nose, with a history of infection for many years. This diagnosis naturally has to be made by the rhinologist in many instances. In a majority of these patients, marked relief followed irradiation. A number have had return of the sense of smell and two have had marked improvement in vision following treatment. Others, who were unable to breathe through the nose at all, have been relieved in this respect. Some who had to have repeated operations for removal of polypoid material from the nose have had no recurrence of this.

Group V. Old, exceedingly chronic polyp formation, usually widespread, is present. Only a small percentage of these cases have received much benefit from irradiation. However, a few of from 15 to 20 years' duration have received definite benefit from treatment.

Groups I, II, and III have been treated with 130 kv.p. with 6 mm. aluminum filter, about 300 r measured in air, given in three or four treatments, over a period of from one to three weeks. Children have been given smaller doses. Groups IV and V have been treated with 200 kv.p. with from 0.5 to 2 mm. copper filter, 600 r measured in air.

Since almost every patient should be seen by both rhinologist and radiologist for diagnosis and follow-up of the results of the treatment, a whole-hearted and

sincere co-operation between these two is absolutely essential, if the best results are to be obtained.

We realize that many radiologists are obtaining just as good or better results than we are, while others are getting nowhere in the treatment of sinusitis. This is, we believe, due largely to the fact that series of cases, which have been failures by other methods of treatment, are routined through a busy clinic without any careful study or individualization by rhinologists and radiologists. Except for the very few specifics that we have in medicine, almost any type of therapy can, save in a small percentage of cases, lead but to failure.

If the radiologist realizes his limitations, and co-operates with the rhinologist and internist experienced in allergy and treats only the types of cases enumerated in this paper, we believe a great deal can be accomplished by irradiation in this field.

We are more enthusiastic than ever before over the results that can be obtained by irradiation in the treatment of certain types of infections of the nasal accessory sinuses, and our conclusions are about the same as those expressed in previous papers.

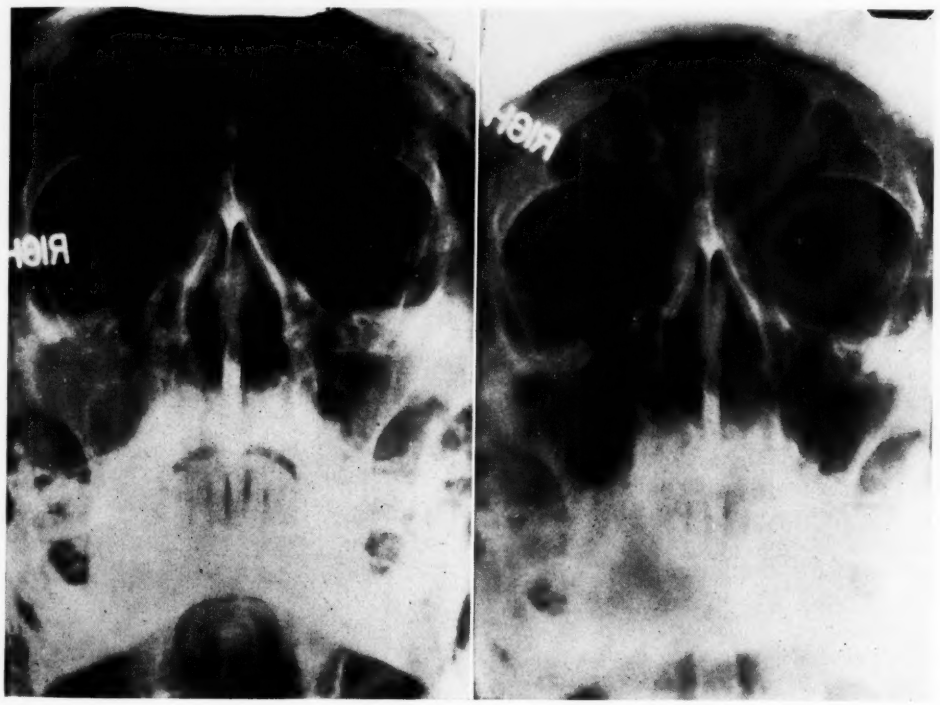

Fig. 8. Fig. 9.

Fig. 8. Case 4, Group IV, Sept. 20, 1937. G. P. McC., white, 28 years of age. Film shows right antrum practically dense. Left antrum shows marked thickening of the membrane. Ethmoid area shows widening, with the type of density usually seen in polyp formation. The patient has had sinus trouble with frequent colds, cough, and nasal discharge for many years. Was under care of allergist for several months, and under care of rhinologists at frequent intervals; at one time for six months, during which time she had frequent washings of the antra. Polyps were removed from the nose six years ago. She had further polyp formation and was unable to smell.

Fig. 9. (Oct. 23, 1937.) The patient was treated in September, 1937, and considers that she has been 90 per cent relieved of symptoms. Has a return of the sense of smell. There is still slight thickening of the membrane in the antra, but there has been marked decrease in the pathology as shown on the film as well as improvement in the clinical symptoms.

SUMMARY

1. Sinus disease is a far more common, complicated, and serious condition than is realized by the general medical profession.

2. Almost every common cold that does not clear up within a reasonable time is a sinus infection. Many are due to allergy.

3. Preliminary sinus films, on patients sent in for chest examinations, disclose a great many unsuspected infections.

4. This, many times, enables the patient to be referred to the rhinologist earlier with better results from treatment.

5. Follow-up films to determine progress are just as important here as in other conditions.

6. In addition to the treatment by the rhinologist, many cases can be markedly benefited by roentgen therapy.

7. We believe there is a definite field for this method of therapy in carefully selected cases of sinus infections.

8. A whole-hearted and sincere cooperation between the rhinologist, radiologist, and the allergist is absolutely essential if the best results are to be obtained.

REFERENCES

(1) BUTLER, F. E., and WOOLLEY, I. M.: Roentgen Therapy in Chronic Sinusitis. RADIOLOGY, **23,** 528–537, November, 1934.

(2) DESJARDINS, A. U.: Radiotherapy for Inflammatory Conditions. Jour. Am. Med. Assn., **96,** 401–408, Feb. 7, 1931.

(3) HANSEL, F. K.: Allergy of the Nose and Paranasal Sinuses. C. V. Mosby Co., St. Louis, 1936.

(4) HODGES, F. M.: Roentgen Ray in Treatment of Carbuncles and Other Infections. Am. Jour. Roentgenol. and Rad. Ther., **11,** 442–445, May, 1924.

(5) Idem: Roentgen Ray in Treatment of Local Inflammations, Cellulitis and Carbuncles. Jour. Am. Med. Assn., **85,** 1292–1294, 1925.

(6) Idem: Roentgen Ray in Treatment of Certain Localized Infections. South. Med. Jour., **19,** 857, 858, 1926.

(7) Idem: Rationale of Roentgen Therapy in Infections. South. Med. Jour., **23,** 259–263, March, 1930.

(8) Idem: Treatment of Mikulicz's Disease. South. Med. Jour., **28,** 205–209, March, 1935.

(9) HODGES, F. M., and BERGER, R. A.: Roentgen Therapy of Some Infections. Jour Am. Med. Assn., **107,** 1551–1555, Nov. 7, 1936.

(10) HODGES, F. M.: The Roentgen Ray: Facts and Fiction. South. Med. Jour., **29,** 1151–1156, December, 1936.

(11) Idem: Roentgen Therapy of Infections of the Nasal Accessory Sinuses. Am. Jour. Roentgenol. and Rad. Ther., **39,** 578–584, April, 1938.

(12) LAW, F. M.: Nasal Accessory Sinuses Roentgenologically Considered. Ann. Roentgenol., **15,** Paul B. Hoeber, Inc., New York, 1933.

(13) MANGES, W. F.: Roentgen Treatment of Infections. South. Med. Jour., **30,** 243–249, March, 1937.

(14) OSMOND, J. D.: Roentgen Therapy of Acute Infections of the Antrum and Frontal Sinus. Am. Jour. Roentgenol. and Rad. Ther., **10,** 374–377, 1923.

(15) RATHBONE, R. R.: Roentgen Therapy of Chronic Sinusitis in Children. Am. Jour. Roentgenol. and Rad. Ther., **38,** 102–108, July, 1937.

(16) WATERS, C. A., and FIROR, W. B.: Article read at 1938 meeting of the American Roentgen Ray Society.

THE ROENTGEN TREATMENT OF ACUTE PERITONITIS AND OTHER INFECTIONS WITH MOBILE X-RAY APPARATUS[1]

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IN 1928, under pressure of necessity, a case of gas gangrene was treated with the mobile x-ray unit, and recovered. The mobile unit was the ordinary unit designed for mobile diagnostic work in general hospitals and rated below 90 kilovolts.

In the first report (1) on the treatment of gas gangrene with the mobile unit, two cases out of eight died. Both of those dying had trunk involvement. In the six who recovered, the infection was entirely, or to a great extent, limited to the extremities. From the outcome of these cases it was thought that probably the mobile unit did not have sufficient kilovoltage to obtain the necessary depth dose to effect a cure in the trunk cases.

This led to a recommendation for the use of higher voltages in treating deep-seated or trunk infections. Since the maximum kilovoltage obtainable from the mobile unit had been used in treating the two cases which died, it was apparent that in the future cases with trunk involvement must be moved to the x-ray department if they were to be treated successfully, or some apparatus producing a higher kilovoltage must be designed to enable the radiologist to treat at the bedside.

Since no bedside apparatus was available, we started to move these patients to the x-ray department. This was done, on a few occasions, and, as these patients recovered promptly, we felt we were well rewarded for our efforts. In fact, we were so impressed with the results that we decided to treat other infections in the trunk.

Peritonitis, following acute appendicitis and other intra-abdominal infections, is relatively common and was selected for a trial. The immediate difficulty encountered was that of obtaining the permission of the clinician to move the patient with peritonitis to the x-ray department, and we fully agreed with the clinician that the dangers involved in moving the patient seemed out of proportion to the chances of improving his condition. The whole thing then resolved itself into providing some means of treating the patient with peritonitis without disturbing him in any way, and, as no equipment was commercially available for this purpose, we felt that it was our duty to devise some means of providing x-ray treatment at the bedside, for those who were too sick to be moved.

In a short tour of the local x-ray dealers' basements, we were able to select from the stock of obsolete and discarded x-ray equipment, a suitable transformer which was mounted upon a wooden base carrying a tube stand. We found two such units, and built two mobile units; they have served our purpose very well. They are not, we hope, the last word in this type of equipment, as we appreciate some deficiencies in this assembly, but we look for a real piece of apparatus to be developed in the near future for this type of work, as we are certain that the results will warrant its production.[2]

[1] Presented before the American Medical Association, Section on Radiology, San Francisco, June, 1938; also read in part before the Twenty-fourth Annual Meeting of the Radiological Society of North America, at Pittsburgh, Nov. 28–Dec. 2, 1938.

[2] Since this paper was presented at the meeting of the American Medical Association in June, 1938, at San Francisco, some of the x-ray manufacturers in this country have built equipment especially designed for this type of work.

The first two cases of peritonitis treated were cases about which the surgeon was especially anxious. In both of these cases,

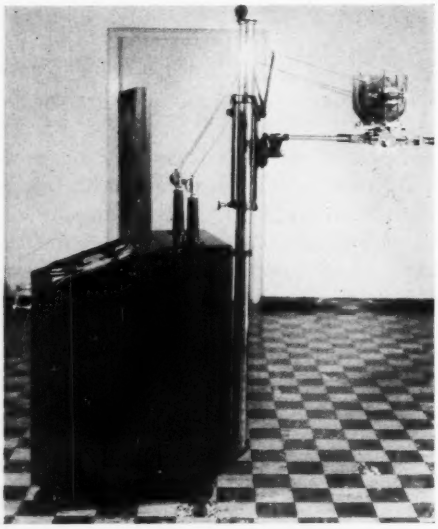


Fig. 1. Mobile x-ray therapy unit.

improvement started promptly with the beginning of the use of the x-ray, and in each instance the surgeon expressed his appreciation of the value of the x-ray in treating his patient. If you wish to make some good friends among your surgical colleagues, become equipped to assist them in their battle to save the lives of such of their patients who come in with ruptured appendices and general peritonitis, and those who, for some unknown reason, develop peritonitis postoperatively, sometimes to the surgeon's surprise and embarrassment.

In presenting this brief paper it would be foolish to attempt to evaluate the exact position of the x-ray in this work. We all realize that many cases of peritonitis, and infections elsewhere, recover quite suddenly after the battle appears lost to the patient. Why such sudden changes take place is frequently not understood by the clinician, and such may have been the situation in the two cases of peritonitis aforementioned. It is possible that the x-ray had nothing to do with the recovery of either, and that it was merely a coincidence that x-ray therapy was started as the patient began to recover. However, the point I am trying to make is that peritonitis is a disease, or a complication, which may take a sudden turn for the better, or for the worse, and nothing concerning the specific curative effect of any single measure, when many remedies are being used on every case, will ever be proven in a short series of cases. Let it be understood, therefore, that we are not attempting to prove anything in this presentation: we are merely relating some experiences in the treatment of 24 cases of peritonitis, and some other acute infectious diseases and complications, at the bedside, with a mobile x-ray therapy unit (Fig. 1). We believe that it has been of definite benefit and recommend that the method be used by others, but we are not interested in attempting to prove it, because of the wide variation in the clinical picture in any series of cases of peritonitis. The criticism which might be advanced against this report, relative to the small number of cases treated, can be answered by referring the critic to the results obtained in the treatment of inflammatory lesions in the regular x-ray department with the stationary type of apparatus for the past quarter of a century.

There can no longer be any doubt as to the efficacy of the method, and the late Dr. Willis Manges pointed out that:

> "The effect of the x-ray in treating gas gangrene, which had resisted other direct methods of therapy, was so nearly specific that it established the x-ray indisputably as of value in the treatment of infectious processes. All other infections heretofore treated with x-ray were self-limited or responded to other measures—not so with gas gangrene."

In our opinion, the results obtained in gas gangrene are not any more spectacular than those obtained in surgical mumps, and many of the mixed infections met with in every-day clinical practice. One can only

judge the efficiency of any method of therapy through bedside observation on the individual case. Naturally, there will be a variation in the outcome for statistical purposes, and statistics are too vulnerable and too open to manipulation to be very impressive to the average clinician, who believes for the most part only what he sees. Our advice to all who wish to help the patient who has a localized infectious process and is too sick to be moved to the x-ray department for treatment, is that he should receive treatment with a mobile x-ray unit capable of producing a satisfactory depth dose, and let the clinician be the judge.

Table I shows a list of cases which we have recently treated at the bedside. This table does not include all cases treated at the bedside during the last ten years, but is used to show the type of case in which mobile therapy is indicated.

TABLE I

Diagnosis	Cases Treated	Living	Dead	Mortality
Peritonitis	24	17	7	29
Streptococcic cellulitis	20	20	0	0
Surgical mumps	14	13	1	7.1
Furunculosis	3	3	0	0
Erysipelas	2	2	0	0
Mastoiditis	3	3	0	0
Ludwig's angina	4	4	0	0
Gas gangrene	12	11	1	8.33
Phlebitis	1	1	0	0
Prophylaxis	9	9	0	0
Pneumonia (lobar)	7	7	0	0
Bacteremia	1	0	1	100
Total	100	90	10	10%

Peritonitis.—When following acute appendicitis and other intra-abdominal infections, peritonitis has responded immediately on many occasions. In a few instances, in the cases of peritonitis, it was necessary to treat the chest for secondary involvement and the response when treating over the lungs and pleura or the subphrenic area was prompt and decisive.

In the peritonitis group two patients who died had complete obstructions at postmortem. The x-ray will not free adhesions. Another patient who died in this same group had a large amount of free pus in the abdomen; the only drainage instituted was a small tube in the *cul de sac.* One must have adequate drainage from all pus-containing cavities. One must be alert to the requirements of each individual case. Some of the acute appendicitis cases received pre- and post-operative treatment and recovered promptly.

No harm came to patients who had preoperative or post-operative treatment immediately after appendectomies. We are inclined to believe that the small doses we use have no injurious effects and do not interfere with the healing of the incision.

Pneumonia.—We have had opportunity to treat only a few cases of pneumonia, but we are convinced by the prompt response in our cases that Powell's (2) work on the x-ray treatment of this highly fatal disease is going to revolutionize its treatment. A mobile therapy unit with adequate kilovoltage seems essential in this work.

Post-traumatic Prophylaxis.—Some severe injuries, with contaminated wounds, were treated on admission to the hospital, and failed to develop any infection. Some were compound fractures, which united promptly without the development of gas gangrene or even the usual osteomyelitis. Our experience clinically, has led us to believe very strongly that the x-ray may be used for the prevention of gas gangrene. We recommend the routine use of a daily dose of 75 r for the prevention of the onset of a gas infection, but insist that tetanus antitoxin be given to prevent tetanus. This applies to all wounds in which a gas-forming infection is likely to occur, such as compound fractures and other penetrating or severely lacerated wounds.

Staphylococcus and Streptococcus Infections.—The streptococcic cellulitis group respond more readily and remain inactive with greater certainty than do the staphylococcic group. This latter group are more stubborn, require treatment over a longer period of time, and are prone to reactivate on the least provocation. The earlier x-rays are used the more effective they will be. Suppuration may occur, then drainage is indicated. Considerable tissue

adjacent to the infected area should be included in the treatment.

One patient in the staphylococcus group died 20 days after x-ray treatment was discontinued. The infection was then apparently under control, but became active a few days later, and the clinicians failed to request additional x-ray treatments, electing to depend upon general measures, transfusions, and sulfanilamide. Usually,

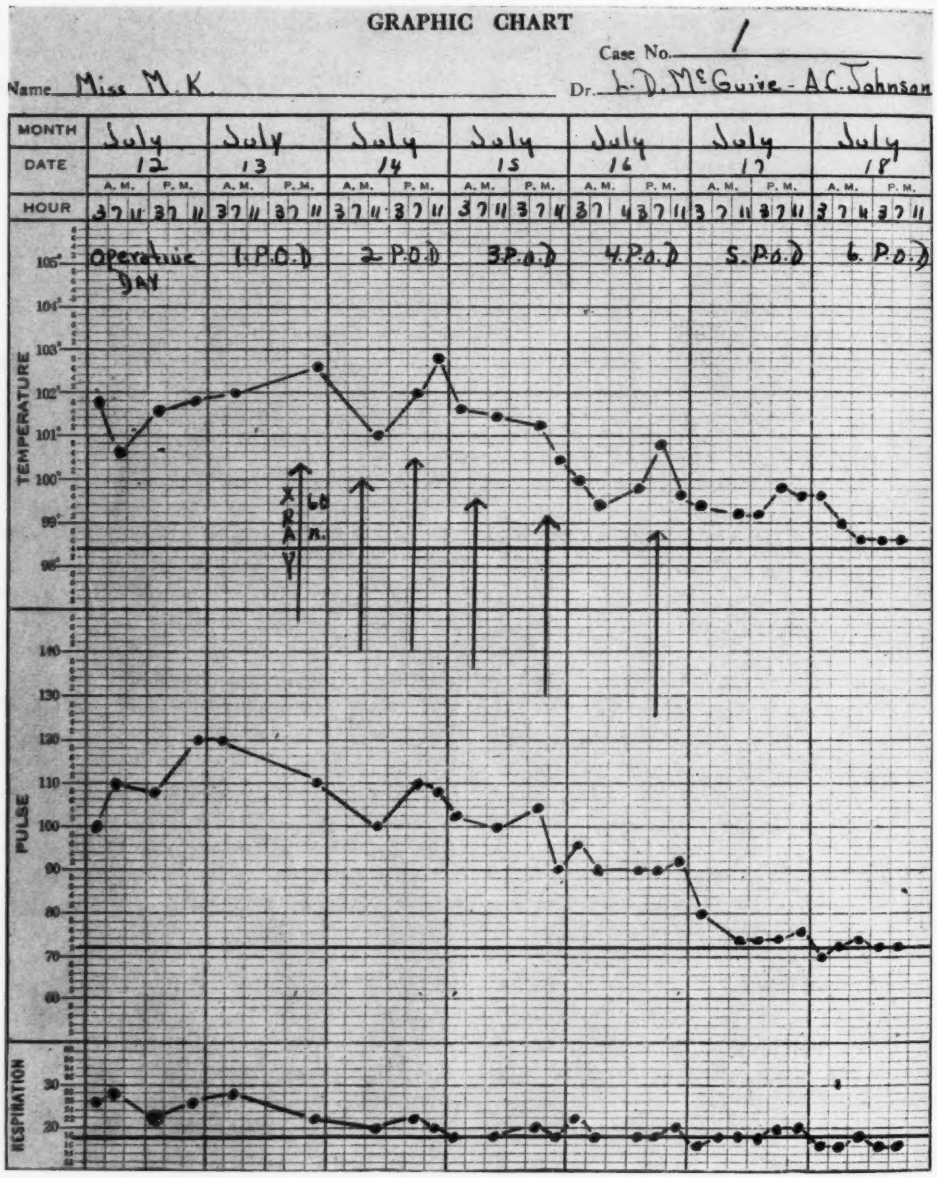


Fig. 2. Case 1. Diagnosis: Peritonitis, post-operative gangrenous appendicitis. X-ray technic: kv. 110; ma. 5; distance 50 cm.; filter 2 mm. Al; r units, 60 per treatment, 360 total; port, abdomen anteriorly; result, excellent.

it is well to continue with a daily treatment for two or three days after the temperature reaches normal, then observe the case for a short time for a possible re-activation of infection.

Ludwig's angina is another serious infection which responded, but less rapidly, to x-ray therapy.

Peritonitis (*Recovery*).—Case 1. Miss M. K., 16 years of age, was admitted to the hospital on July 21, 1934, with a diagnosis of acute gangrenous appendix. White blood cell count was 19,400, 89 per cent polymorphonuclears. The patient was operated upon immediately. The appendix was greatly distended and gangrenous on the tip, and there was free fluid in the peritoneal cavity. The following day, the diagnosis of general peritonitis was made, and x-ray treatment was started immediately. The patient received one treatment the first day, two on the following two days, and one on the fourth day. The response was prompt and she left the hospital on the eighth post-operative day.

Two features in this case are worthy of note. X-ray treatment was started the next day after operation, the incision healed by primary intention, and the patient left the hospital on the eighth post-operative day. The Wangensteen apparatus and sulfanilamide were not used.

Note in Figure 2 the steady decrease in the pulse rate which seems characteristic of cases treated with x-ray. They seem definitely less toxic quite soon after x-ray treatment is started.

Case 2. T. O. B., male, aged 22 years, rock quarry foreman, was admitted to hospital with a diagnosis of appendicitis on Feb. 7, 1938. He was operated upon immediately after admission and a retrocecal appendix was found. White blood cell count on admission was 18,300, 79 per cent polymorphonuclears. The appendix had perforated at the tip, was acutely inflamed, and there was bloody fluid and free pus in the abdominal cavity. X-ray treatments were started two hours after operation, at 7:30 P.M., and he received two treatments the following day, one the next day, two the following day, and one the last day. His clinical improvement was very prompt, and at no time did he show evidences of toxicity or abdominal distress, such as is commonly found post-operatively. He had practically no distention. The Wangensteen apparatus was not used at any time and he received no sulfanilamide. He left the hospital on the tenth post-operative day. It is worthy of note that this patient received treatment within two hours after the incision was made and for the following four days thereafter, but healed by primary intention. This fact is reported because many object to the use of the x-ray immediately following operation, fearing that there may be some interference in the union of tissues at the incision. In this series, some cases were treated before and others immediately after operation, with no apparent effect on the operative wound.

Case 3. Mrs. O. S., white, 45 years of age, was admitted to the hospital on April 26, 1937, for pelvic surgery, which was quite extensive. Resulted in the removal of a uterine fibroid, appendix, tubes, and a cystic right ovary. She was operated upon on April 27, 1937, developed a fever immediately after the operation, and steadily became worse, with distention and evidence of peritonitis. On the fifth post-operative day she was extremely sick with a grave prognosis, when x-ray therapy was started. Two treatments were given the first day, two the second day, one the third day, one the fourth day, after which her temperature remained normal.

This patient made a spectacular and impressive recovery. The surgeon expressed his appreciation for the aid given to a patient who appeared to be steadily losing ground under the usual routine treatment of the Wangensteen apparatus, transfusions, and general supportive measures. She received no sulfanilamide.

Comment: This patient was absolutely too sick to be moved to the x-ray department and the mobile x-ray therapy unit seemed beyond a doubt to be the greatest factor in her recovery.

Pneumonia (Recovery).—Case 4. Master D. T., aged six years, was admitted to the hospital on Jan. 15, 1938, with a diagnosis of appendicitis and hernia. His appendix was removed and the hernia repaired on the day of admission. Two days later, clinical diagnosis of pneumonia (Type 3) was made. The temperature was 105°, but an x-ray film on Jan. 17, 1938, failed to disclose any evidence of consolidation.

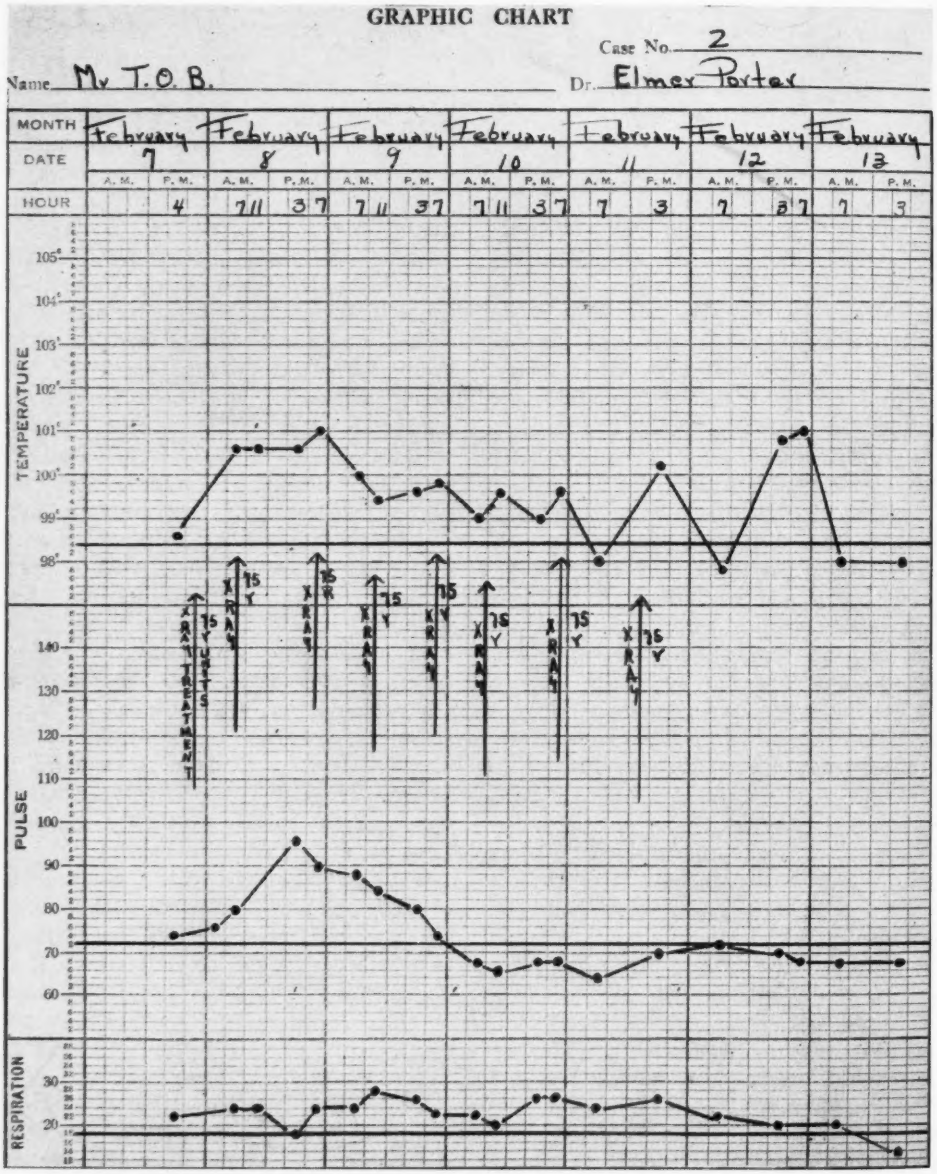


Fig. 3. Case 2. Diagnosis: peritonitis, perforated appendix. X-ray technic: kv. 110; ma. 5; distance 50 cm.; filter 3 mm. Al; r units, 75 per treatment, total 600; port, lower abdomen anteriorly; result, excellent.

However, x-ray treatment was given over the chest at the clinician's request. The patient was also treated the following day. On the day following this, Jan. 19, 1938, a film of the chest disclosed a consolidation in the upper lobe. The patient again received x-ray treatment, and also one treatment per day for the following two days, making five treatments on five successive days. An x-ray film taken on Jan. 23,

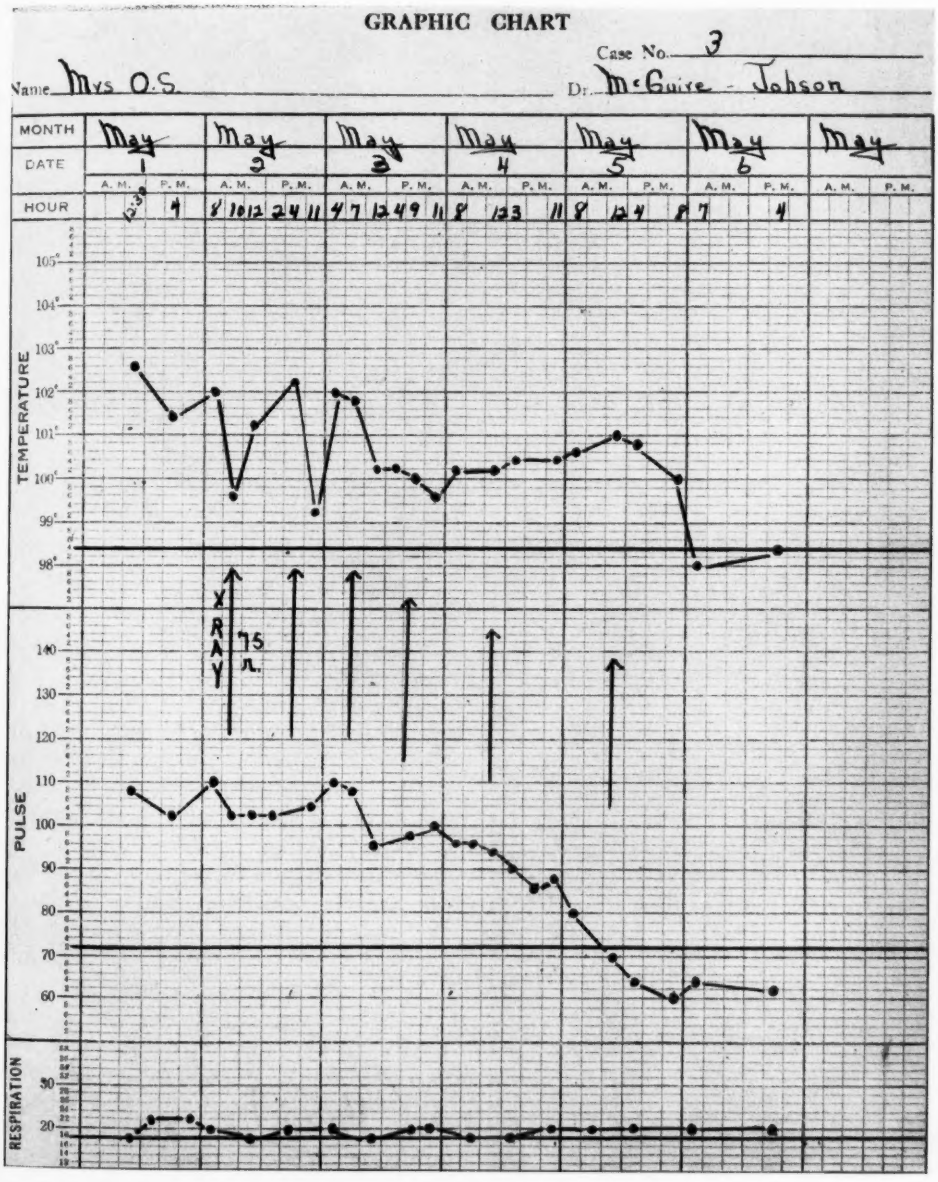


Fig. 4. Case 3. Diagnosis: peritonitis. X-ray technic: 100 kv.; ma. 5; distance 40 cm.; filter 2 mm. Al; r units, 80 per treatment; port, abdomen; result, excellent.

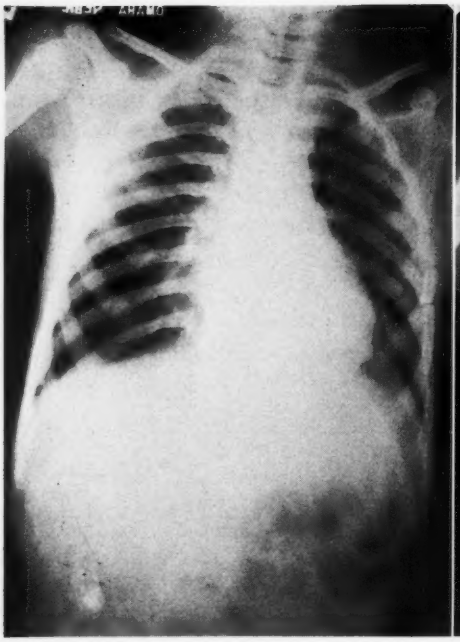


Fig. 5. Case 4. Patient D. T., pneumonia; recovered. Film taken on Jan. 17, 1938.

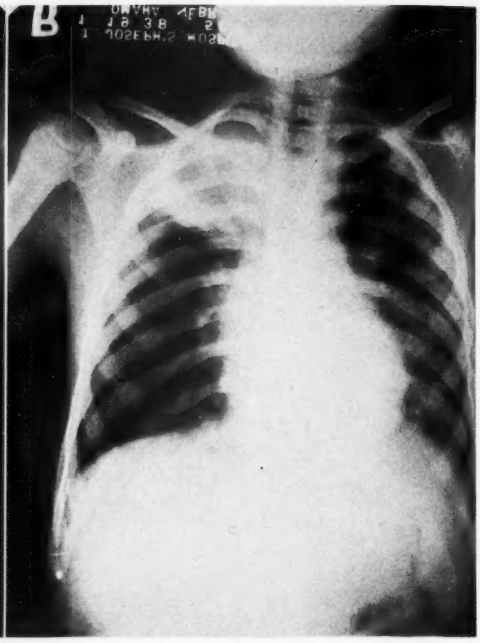


Fig. 6. Case 4. Patient D. T., pneumonia; recovered. Film taken on Jan. 19, 1938.

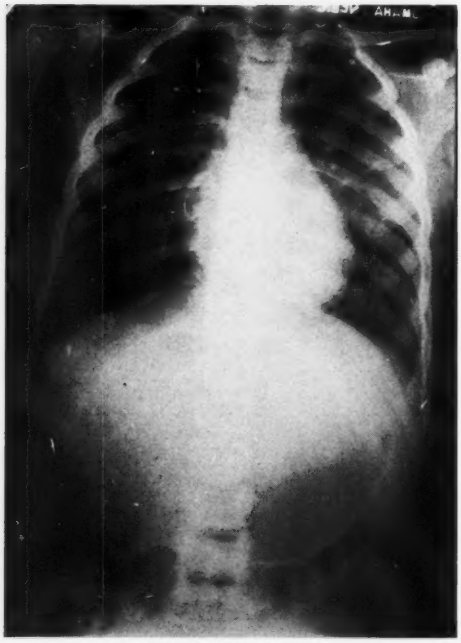


Fig. 7. Case 4. Patient D. T., pneumonia; recovered. Film taken on Jan. 23, 1938.

1938, showed the pulmonary consolidation in the upper right lung-field to have completely disappeared. The patient was discharged from the hospital on the day the last film was taken.

This case was very interesting in that the patient was diagnosed clinically before the x-ray showed any evidence of consolidation, and was treated once each day for a period of five days. The films showed the lungs clear at the beginning and at the end, the entire period being but seven days. He received no sulfanilamide. He was in the oxygen tent and received daily x-ray treatments, 60 r per day, 400 r units total.

Lobar Pneumonia (Recovery).—Case 5. Miss J. B., eight years of age, was admitted to the hospital on Jan. 30, 1938, at 4:30 P.M., complaining of severe pain in the abdomen and shortness of breath. Her temperature was 104.6°; pulse, 110. She coughed considerably and had a rusty sputum. White blood cell count on admission was 20,300, and the diagnosis was

lobar pneumonia. This diagnosis was confirmed by x-ray films which showed a consolidation in the upper right lobe.

X-ray treatment was started the second day after admission. The temperature dropped on the third day after admission. She was given six x-ray treatments in all, and left the hospital on the twelfth day. She received no sulfanilamide, no transfusions, no oxygen. She was on a high ca-

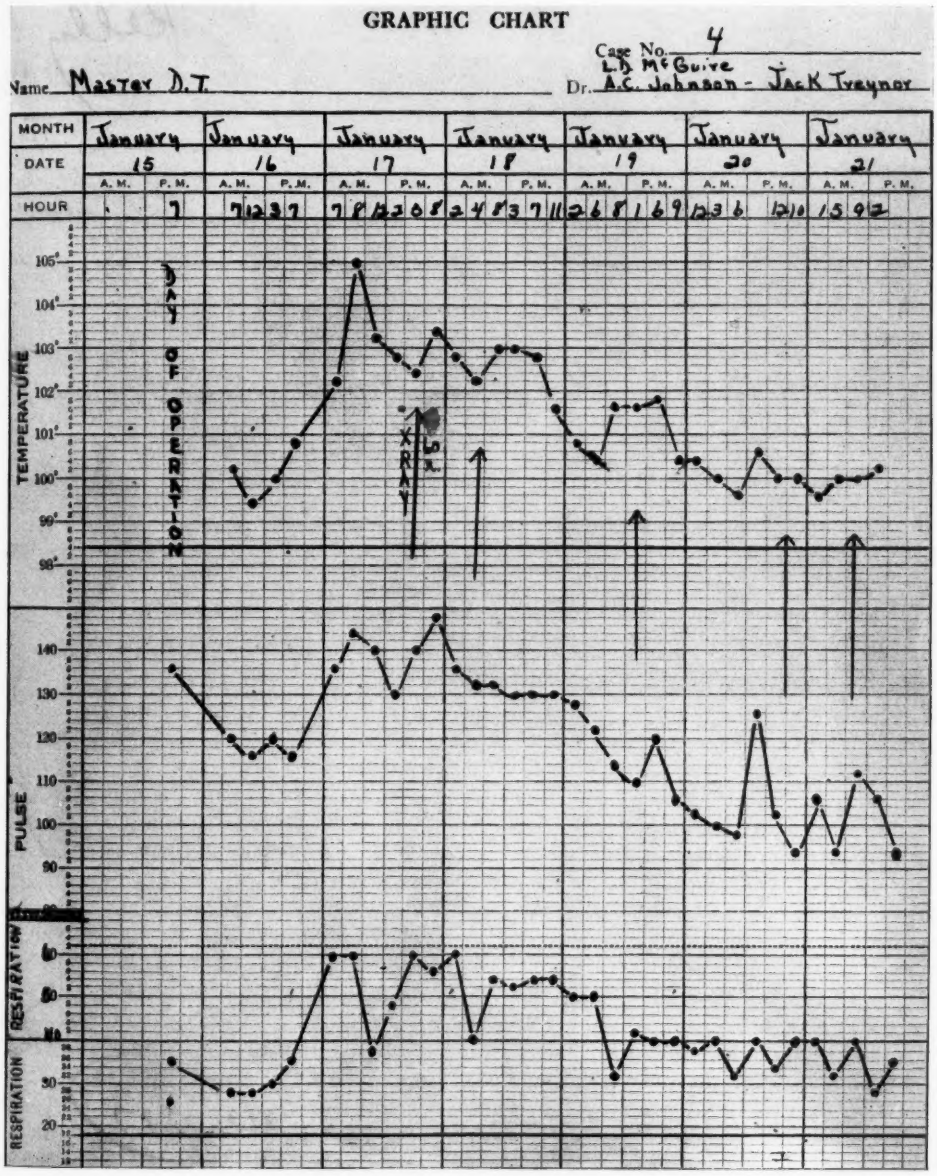
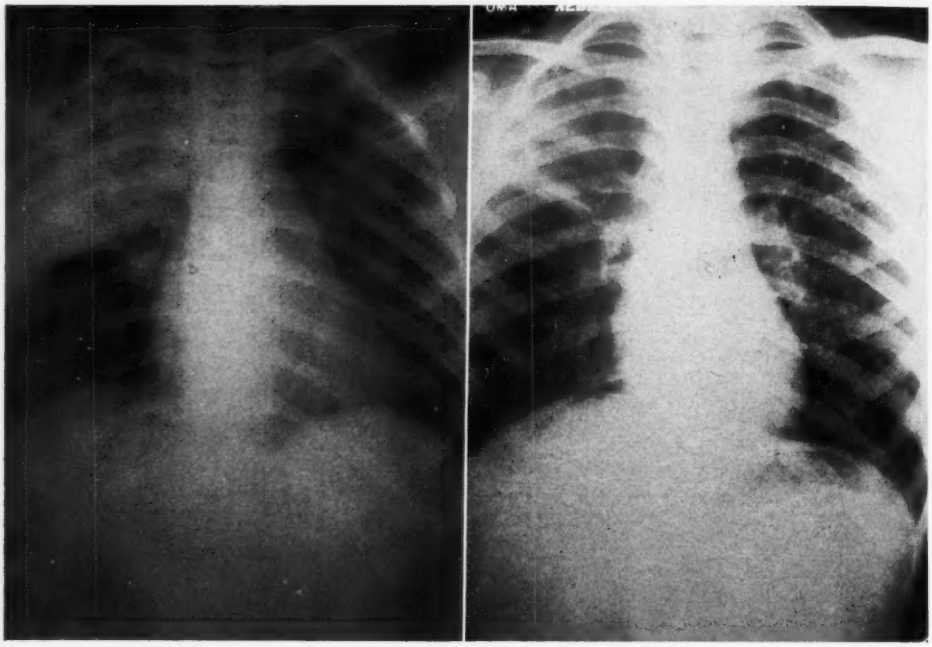


Fig. 8. Case 4. Diagnosis: lobar pneumonia, Type III. X-ray technic: kv. 110; ma. 5; distance 50 cm.; filter 3 mm. Al; r units, 60 per treatment, total 300; port, chest anteriorly; result, excellent.

loric soft diet, had turpentine stupes and colonic irrigations, and was dismissed on Feb. 12, 1938.

Prophylaxis.—Case 6. Mr. G. K., aged 20 years, was admitted to the hospital on Dec. 9, 1938, immediately following compound fracture of left tibia. The wound was debrided and scrubbed with tincture of green soap and sterile water, and then closed loosely over a soft rubber drain. A plaster cast dressing was applied, leaving an open window over the site of the external wound. He received one x-ray treatment of 80 r each day for three days, or a total of 240 r. The patient showed no evidence of infection and the wound healed promptly. New bone was also formed rapidly about the ends of the fractured bones and he had a firm bony union which he used for weight-bearing in four months' time. The x-ray films show the character of the union obtained, which should encourage those who are timid in the use of x-ray therapy over fracture site, lest non-union result.

We believe one of the most important uses for a mobile unit is the prevention of gas gangrene in compound fractures and similar injuries.



Figs. 9 and 10. Case 5. J. B., eight years of age, lobar pneumonia; recovered.

Surgical Mumps (Recovery).—Case 7 J. H., male medical student, aged 23 years. was admitted to the hospital on March 18, 1938, with acute appendicitis. He was operated upon on the same day. The convalescence was quite stormy, with abscess formation in the left abdominal wall which was drained on April 14, 1938, followed by development of bilateral parotitis, two days after the second operation, on the twenty-ninth hospital day.

Comment: Clinically, the patient had a severe parotitis, but his temperature dropped promptly after x-ray therapy was started. He received two treatments the

first day, two the second day, one the third day, and one the fifth day. A clinician, who as a rule is dubious as to the effect of x-ray treatment as a therapeutic aid, expressed satisfaction with the prompt response to this treatment. The patient received no sulfanilamide.

Cellulitis.—Case 8. J. C., white male, aged 45 years, was admitted to the hospital on March 28, 1938, complaining of pain in the right leg, fever, and chills, of ten days' duration. His temperature was 104°, pulse 102, respirations 22. Blood cell count, 14,800 whites. He gave a his-

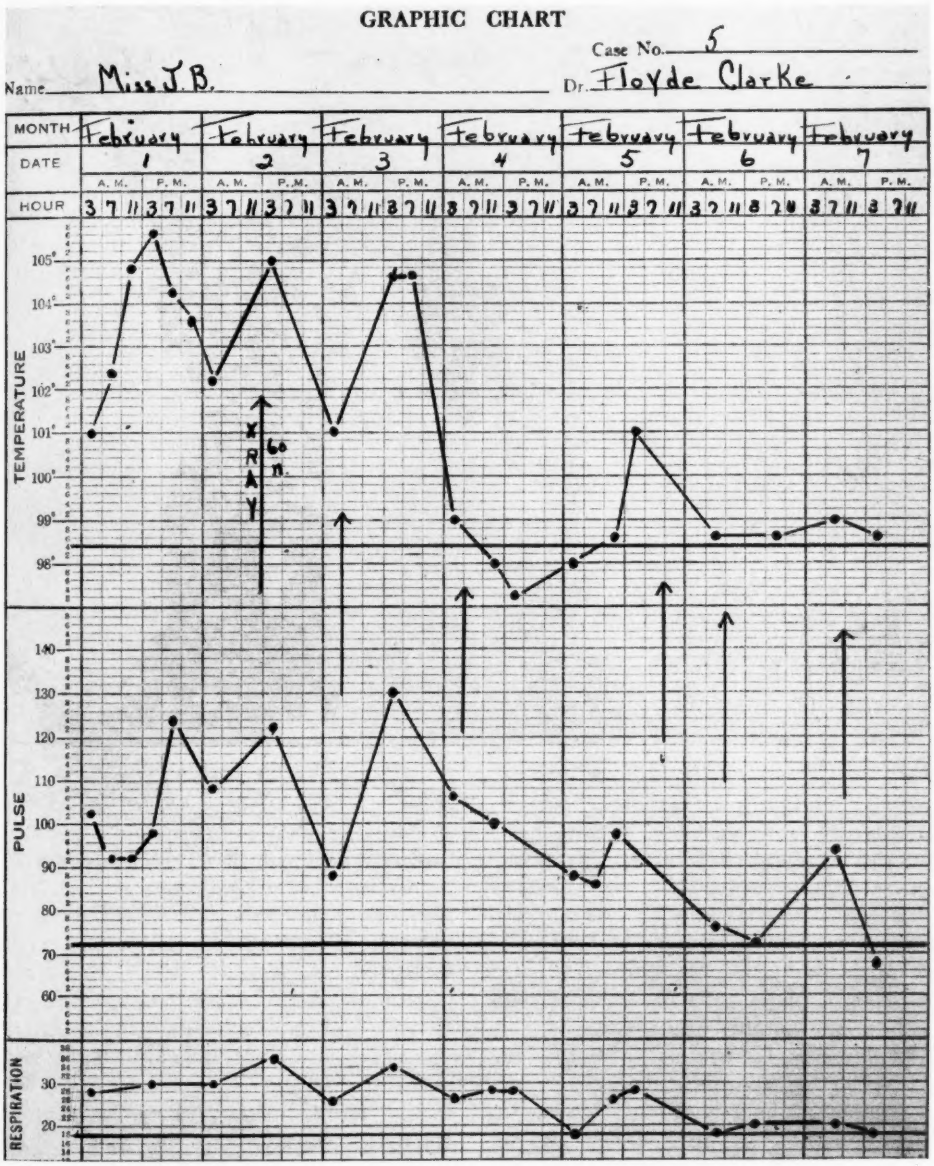


Fig. 11. Case 5. Diagnosis: lobar pneumonia. X-ray technic: kv. 110; ma. 5; distance 50 cm.; filter 3 mm. Al; r units, 60 per treatment, total 360; port, entire chest anteriorly; result, excellent.

tory of stepping on a nail which penetrated his foot two weeks before.

Hot packs of magnesium sulphate and x-ray therapy were ordered. The first x-ray treatment was given four hours after admission. One treatment was given each day for the following three days; in all, four treatments were given. His temperature began to drop immediately after the first treatment and was normal the last two days of his stay in the hospital. He received no tetanus antitoxin and no sulfanilamide. He returned home and had no further complications.

Comment: The x-ray therapy seemed to be of immediate aid in this case and undoubtedly cut down the period of hospitalization.

Gas Gangrene (*Recovery*).—Case 9. Mrs. H. B., negress, 27 years of age, entered County Hospital, on April 20, 1938, with a history of having been struck on the jaw by her husband three days previously. The first day following the injury the jaw was painful and markedly swollen, but the patient was not especially ill. The second day following the injury, however, the pain increased, the jaw and the side of the neck became markedly swollen and puffy. The patient had severe headache, nausea and vomiting, and five chills during the day, each of which lasted from 15 to 20 minutes. The third day following the injury the patient was taken to the Creighton Dispensary, and from there was immediately sent to the County Hospital, where, on

Fig. 12. Case 6.

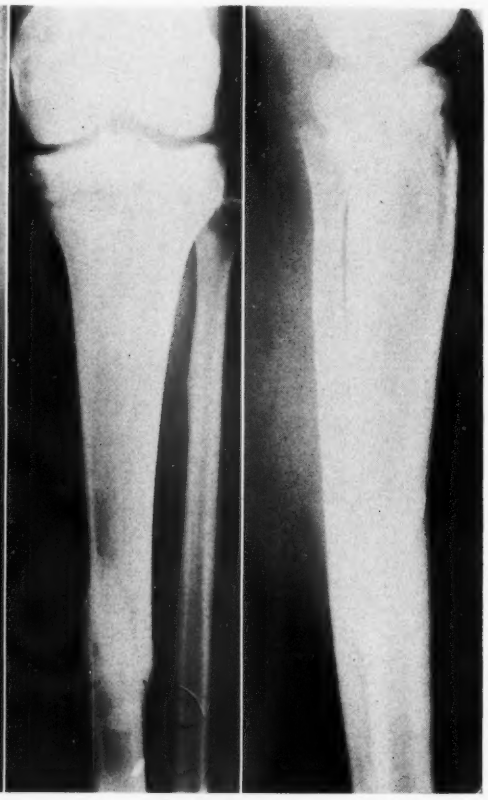


Fig. 13. Case 6.

admission, an x-ray film showed a fracture of the mandible with a large amount of gas in the soft tissues. Blood cell count on admission was 18,000 whites with 61 per cent polymorphonuclears. The Wassermann test was negative. Incision and drainage was done by Dr. Yechout, on April 21, 1938, and a residual area of pus was drained on May 4, 1938. The patient received nine x-ray treatments.

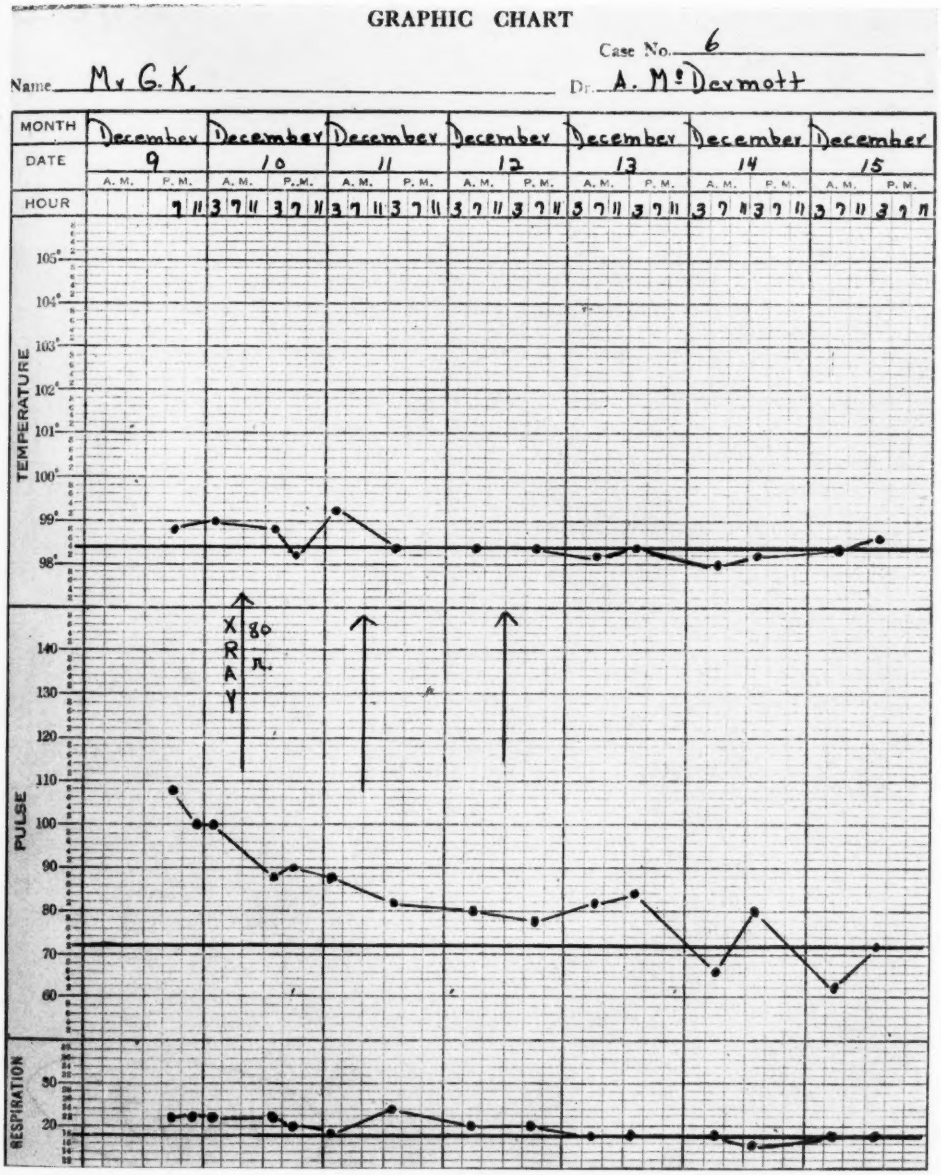


Fig. 14. Case 6. Diagnosis: compound fracture of the right tibia. X-ray technic: kv. 110; ma. 5; distance 50 cm.; filter 3 mm. Al; r units, 80 per treatment, total 240; port, right leg anteriorly only; result, excellent.

It is worth noting in this case that the patient received no gas bacillus serum, no sulfanilamide, conservative surgery, and made a prompt and satisfactory recovery, using the x-ray as the principal therapeutic agent.

ACTION OF X-RAYS

Dr. Desjardins (3), from clinical observations and an extensive review of the experimental and clinical reports on the treatment of inflammations with x-ray, makes the suggestion that white cells prob-

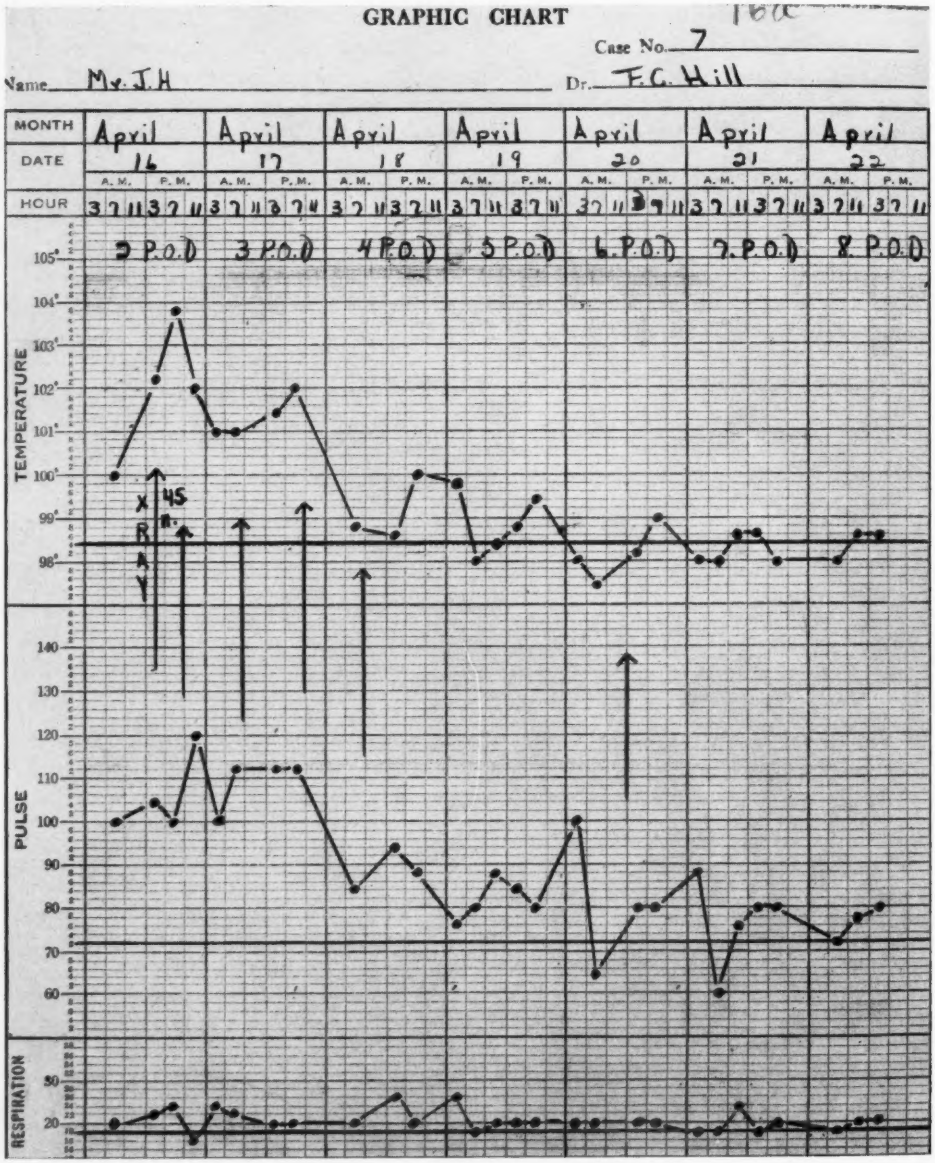


Fig. 15. Case 7. Diagnosis: surgical parotitis. X-ray technic: kv. 110; ma. 5; distance 50 cm.; filter 3 mm. Al; r units, 45 for three treatments and 60 for three treatments, total 315; port, both parotid glands; result, excellent.

ably undergo lysis when radiated and in this lytic process antibodies, or other defense measures, are presumably freed in the infected area. The benefits almost uniformly obtained through treating an infection with x-ray treatment would lead one to believe that Dr. Desjardins' suggestion as to the effect of the x-ray in treating inflammations is correct. To free these antibodies twice each day seems particularly helpful, in the fast-moving infections.

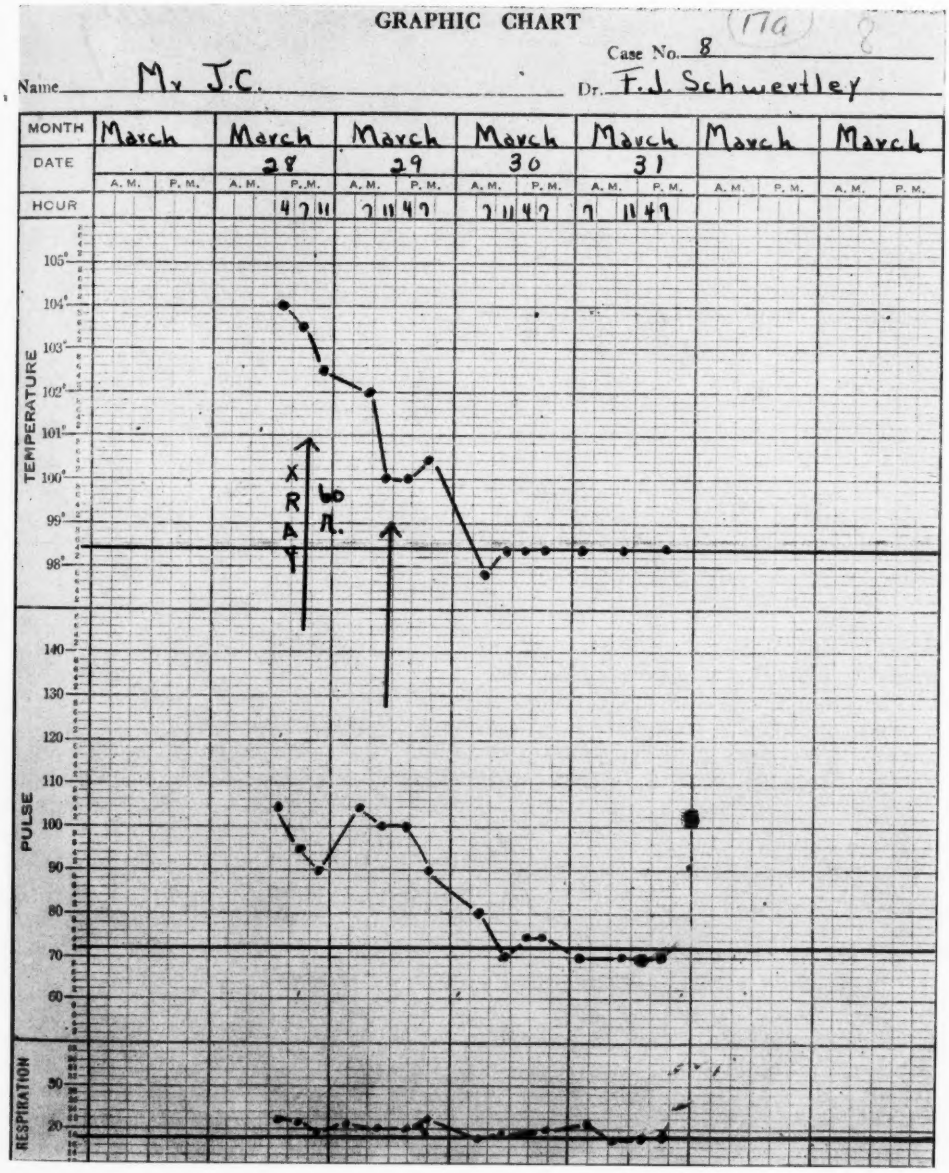


Fig. 16. Case 8. Diagnosis: cellulitis of foot, penetrating wound. X-ray technic: kv. 100; ma. 5; distance 40 cm.; filter 3 mm. Al; r units, 60 per treatment; port, foot and ankle area, one surface; result, excellent.

Regardless of the mode of action, one is soon convinced by the results obtained. We encourage others to treat at the bedside and judge for themselves. In instances in which combined treatment is necessary, as in most of these cases, the clinician is at all times the best judge as to what helps the patient. The x-ray is no miracle worker, it is no cure-all. It is a great aid in treating infections in various locations, is quite universally compatible, and should be used in conjunction with all the safe measures usually employed in treating the conditions.

INDICATIONS FOR X-RAY TREATMENT

1. In local infections which—
   (*a*) are likely to spread to adjacent tissues;
   (*b*) may develop complications in some distant organs;
   (*c*) are likely to destroy large areas of tissue;
   (*d*) are associated with severe toxemia;
   (*e*) have apparently become stationary with no evidence of repair.

2. As a prophylactic measure in contaminated wounds to prevent infection from becoming established (compound fractures).

3. In bacteremia: There is no contra-indication to the treatment of a local area of infection from which a bacteremia had its beginning, but in our experience we have not been able to determine whether or not any good has been accomplished by such treatment.

4. In general, in cases in which infection is present, x-ray therapy is indicated, pre-operatively and post-operatively.

5. Finally, do not depend upon x-ray therapy to prevent tetanus; use antitoxin.

DANGERS

Wherever the x-ray is used some danger is present. This has been recognized for a great many years. X-ray treatments should be prescribed only by a radiologist. Dangers are acute radiation effects, chronic or slow radiation effects, and electrical shock. X-ray treatments should be given only by a radiologist or a trained technician under the direct supervision of a radiologist; others may have trouble.

CONTRA-INDICATIONS

If the treatments are given under the direction of an experienced radiologist, there are no absolute contra-indications. Repeated small doses of from 50 to 70 r morning, and of from 50 to 70 r evening, for from three to five days during the height of the infection, are recommended. The correct technical factors must be prescribed by the radiologist so that the total dosage given is under the minimum which might damage the skin. This is a clinical problem and the radiologist is responsible. Not every patient treated with x-ray therapy will get well, but in no instance has any harm, known or suspected, come to any patient receiving treatment. Some filter should always be used.

X-RAY TECHNIC

(*a*) Kilovoltage: Sufficient to thoroughly penetrate the involved area; varies from 90 to 135 kv.

(*b*) Time and milliamperage: From 60 to 100 r units each treatment through each port; dosage should vary depending on size of the port. A smaller dose may be used on the third or fourth day of the disease; 50 r units are probably sufficient for late treatments. Sub-acute cases must be treated an indefinite time so smaller doses are advised.

(*c*) Ports: Sufficient to cover all involved tissues and adjacent suspected area.

(*d*) Distance: Fifteen inches (40 cm.).

(*e*) Filter: No harm has come from unfiltered therapy but we believe it to be dangerous, and it is not recommended as recoveries have occurred with rather heavy (0.5 mm. Cu) filtration. It is recommended that some filter be used; the ab-

sence of filtration may be a legitimate criticism of this procedure and we are opposed to its omission.

(*f*) Space factor: The reason for treating twice each day, which we insist upon, is based upon the observation that the results, in the treatment of infections, were better when the space factor or time between treatments approximately coincided with the rate of growth (on culture media or by clinical estimation) of the etiologic organism.

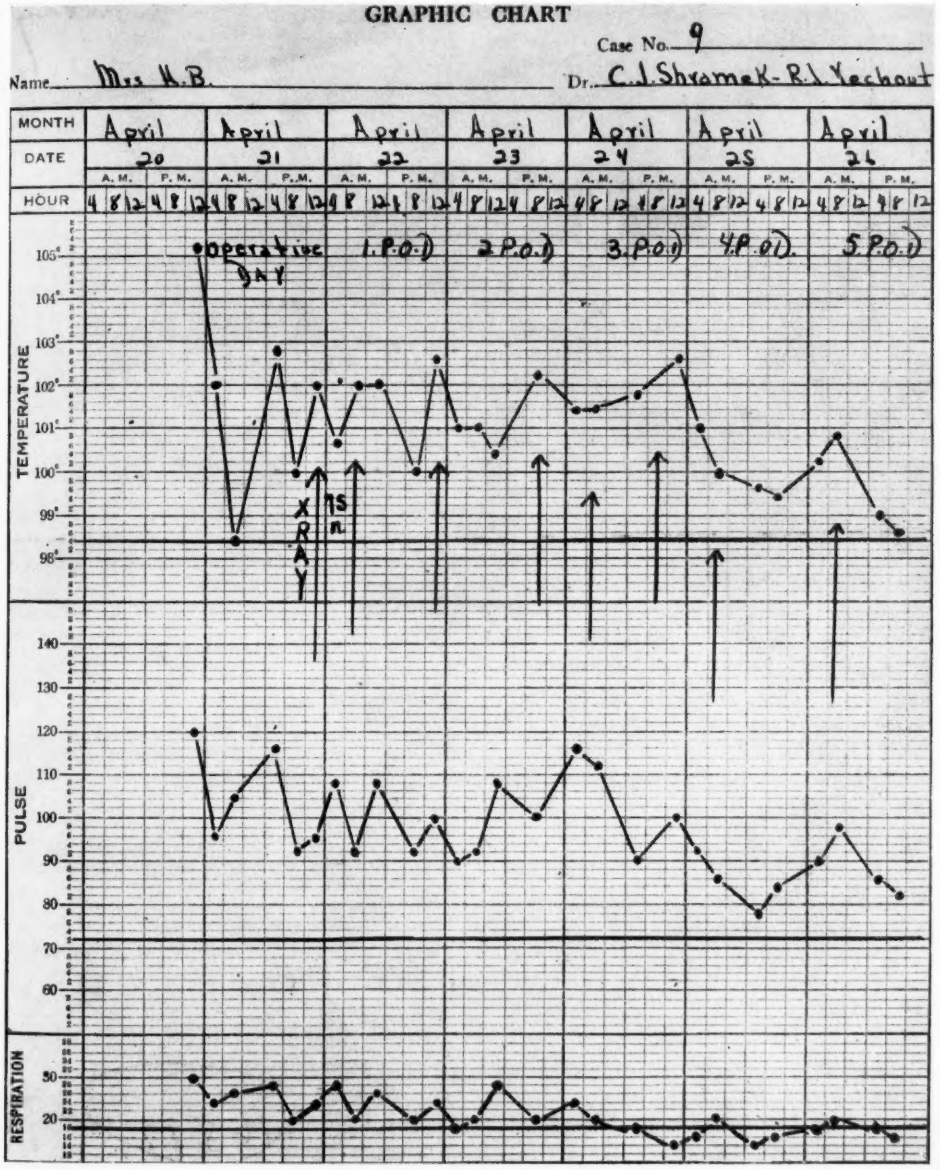


Fig. 17. Case 9. Diagnosis: gas gangrene complicating fractured mandible. X-ray technic: kv. 110; ma. 5; distance 40 cm.; filter 1 mm. Al; r units, 75 per treatment, 675 total; port, left side face and neck; result, excellent.

ADDITIONAL MEASURES

We have the greatest respect for the value of the Wangensteen suction apparatus. We believe this to be an indispensable aid in the treatment of many of these cases, but feel that the use of the x-ray will definitely shorten the length of time the suction apparatus is in use, and, in some instances in which x-ray therapy is started early, the use of the tube is not required.

The use of the oxygen tent is another therapeutic development which has undoubtedly saved many lives.

Blood transfusions have also appeared to be the deciding factor in other cases.

Small doses of sulfanilamide are still an uncertain element, but large doses, following which the patient becomes cyanosed, have, in our opinion, been definitely inhibitory to any beneficial effect the x-ray may produce. As a general rule, in the usual case, we get at least a temporary improvement following radiation therapy, slowing of the pulse probably being the most evident, but in those cases which have been saturated with sulfanilamide before any x-ray treatments are given, we have failed to note even the slightest improvement following the use of the x-ray. Whether the anoxemia, or other blood changes associated in the sulfanilamide-cyanosed patient, prevents any effect from the x-ray or not cannot be stated definitely at this time, but we prefer to treat the patient without the aid of large doses of sulfanilamide.

CONCLUSIONS

This material is merely presented to make available to others who are interested, some clinical facts which we have observed while treating patients with a bedside therapy x-ray apparatus. Practically all of these lesions, with the exception of gas gangrene, may or may not recover when very little is done for them, so nothing can be proven by any series of statistics; cases observed clinically are convincing. As data accumulate relative to the use of the mobile x-ray therapy apparatus, undoubtedly much improvement in technical procedures will result. At the present time we have outlined, in a general way, the technic we have used in treating numerous infections in patients whom we thought it advisable to treat without moving to the x-ray department. This is done in the interest of the patient who is too sick to be moved, or is held fast in a room by the oxygen tent, the Wangensteen apparatus, or intravenous apparatus, all of which are commonly used essentials in treating the seriously sick. We believe that the x-ray is an additional aid in treating some of these patients and that it can be brought to the patient in the form of a mobile unit, having greater kilovoltage than the present-day diagnostic (90 kv.) mobile unit.

BIBLIOGRAPHY

(1) KELLY, J. F.: The X-ray as an Aid in the Treatment of Gas Gangrene. RADIOLOGY, **20,** 296–304, April, 1933.

(2) POWELL, EUGENE V.: The Roentgen Therapy of Lobar Pneumonia. Jour. Am. Med. Assn., **110,** 19–22, Jan. 1, 1938.

(3) DESJARDINS, A. U.: Radiotherapy. Jour. Am. Med. Assn., **105,** 2064–2071, Dec. 21; 2153–2161, Dec. 28, 1935.

(4) KELLY, J. F.: The Present Status of the X-ray as an Aid in the Treatment of Gas Gangrene. RADIOLOGY, **26,** 41–44, January, 1936.

(5) KELLY, J. F., and DOWELL, D. A.: The Present Status of the X-ray in the Treatment of Gas Gangrene. Jour. Am. Med. Assn., **107,** 1114–1118, Oct. 3, 1936.

FURTHER EXPERIENCE WITH ROENTGEN THERAPY FOR BRONCHIECTASIS[1]

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IN A previous paper we reported the successful use of roentgen therapy in the treatment of chronic suppurative bronchiectasis (11), and the present communication is a report of our further experience in the treatment of this disease.

Rationale of the Use of Roentgen Therapy for Chronic Bronchiectasis.—Although it seemed that early investigators of the action of roentgen rays on various organs reported that the lungs were relatively invulnerable to the action of the rays, the recent introduction of apparatus capable of delivering shorter wave length and larger depth doses has demonstrated that, within certain limits, definite tissue reactions can be produced in the lungs and pleural cavities (6). It was the thought that an analogy might be drawn between the salivary glands and the bronchial mucous glands in their reaction to roentgen rays that led primarily to this work on their use in bronchiectasis. Exposure of the salivary glands to roentgen rays brings about a diminution verging upon abolition of secretion. It was thought that if a comparable reaction could be induced in the bronchial mucosa of bronchiectatic areas, a comparable diminution of secretion and hence expectoration might be expected. However, that such an effect can be produced in the bronchial mucosa of human beings, although supported by some experimental work on animals, is problematical and perhaps unlikely (2). Further explanatory hypotheses may be adduced to explain the successful action of roentgen rays in suppurative bronchiectasis; such as, possible enhancement of immunity processes both through the action of the rays in stimulating antibody action, and the physico-chemical alterations of the local tissue reactions. It is, perhaps, most logical to assume that the results we have obtained in chronic suppurative bronchiectasis, so far as our present knowledge of the known reaction of tissues to roentgen rays can teach us, are due to the action of roentgen rays on chronic inflammatory processes (5).

Clinical Application of Roentgen Therapy.—Based upon the above outlined concepts of the action of roentgen radiation upon the chronic inflammatory bronchial and peribronchial lesions and upon the mucus-secreting bronchial epithelium, roentgen therapy was instituted in a series of cases of chronic suppurative bronchiectasis (1). No acute case or cases with recent onset were treated, because it is of considerable importance to be certain that a patient is not suffering from an ordinary superimposed acute upper respiratory infection, which is making otherwise "dry" dilatations "wet." It is well known that bronchiectasis may be characterized by spontaneous remissions and exacerbations with seasonal variations. Therefore, all the patients subjected to treatment were previously observed over a period of many months, at least, and were known to have a chronic lesion with sustained high level of expectoration without marked spontaneous remissions. All the patients were thoroughly investigated by means of bronchography and bronchoscopy and the unequivocal diagnosis of chronic suppurative bronchiectasis was thereby clearly established (3, 4).

Diagnosis of Bronchiectasis.—It is of great importance to point out that chronic bronchiectasis is a diagnosis of exclusion. The term "bronchiectasis," unless qualified, means a state of the bronchi—not a disease in the strict sense of the word. The diagnosis of bronchiectasis must be considered as incomplete and inaccurate unless one is able to diagnose the location of the

[1] Presented before the Twenty-fourth Annual Meeting of the Radiological Society of North America, at Pittsburgh, Nov. 28–Dec. 2, 1938.

disease, *i.e.*, what lobe or lobes are involved and the size and distribution of the dilatations. But of paramount importance is the necessity to ascertain the presence or absence of various local features, such as pulmonary tuberculosis, pulmonary abscess, bronchial foreign body, bronchial adenoma, and bronchial carcinoma. The diagnosis cannot be made upon the clinical history alone, suggestive as it may be. A clinical picture suggestive of bronchiectasis must always be substantiated by bronchography and bronchoscopy. The bronchogram must be bilateral and map out the main branches on both sides. Bronchoscopy must enable one to rule out the presence of foreign body and newgrowth. It is of great therapeutic importance, from our standpoint, to observe which bronchi are discharging and are the sources of expectoration. This should be done *immediately* prior to treatment, in order that a diseased lobe of recent onset be not overlooked.

The majority of the patients had been variously and unsuccessfully treated by bronchoscopic drainage and lavage, pneumothorax, phrenic nerve interruption, and climato-therapy. They were treated by roentgen therapy as a last resort. The alternative in these patients was radical operative intervention, such as lobectomy or pneumonectomy (7).

Classification of Bronchiectasis.—Group 1. The first group would comprise those patients whose clinical symptoms suggest only an aggravated form of chronic bronchitis with superadded catarrhal infection. The clinical course is benign, suppuration is not noticeable, the patients suffer only from cough with variable amounts of mucoid or purulent sputum, febrile episodes are rare, pneumonitis and hemoptysis are absent or very infrequent. The only clinical complaints are cough and expectoration. These patients have rarely required hospitalization and have carried on ordinary activity fairly well for long periods of time. Seasonal variations are marked and disablement is rare. The expectoration may have marked remissions, with periods of entire freedom from symptoms. The question here to be resolved is one of prognosis. The possibility of serious progression of infection in catarrhal processes is known to be slight unless there is a superadded attack of pneumonia. Foul suppurative bronchiectasis most often arises in a lung damaged by an attack of true pneumonitis, rarely as a progression of the lesions in a catarrhal process. Lobectomy done for this type of catarrhal lesion will show a very low mortality. The only justification for lobectomy for this type of lesion is the assumption that these patients are due to progress, within a few years, to the more severe forms of infection. The validity of this assumption is to be questioned, inasmuch as our present evidence goes to show that this sequence has not arisen, but rather that the definitely suppurative type of bronchiectasis most often arises in a lung damaged by pneumonitis with failure of the lesion to resolve. To recapitulate this argument, one must state that lobectomy for this type of lesion, although showing a low mortality rate, is not the mortality rate for suppurative bronchiectasis, and further, that lobectomy for this type of lesion as a prophylactic measure rests upon an exceedingly questionable assumption that the catarrhal form of bronchiectasis usually progresses to the severe forms of infection (8).

Group 2. In a second grouping of bronchiectasis would be placed those patients who are obviously suffering from a severe chronic infection. The sputum is profuse and abhorrently fetid; cough is harassing and always productive; episodes of fever and pneumonitis with progression of symptoms are common; clubbing of the digits is marked; hemoptyses not unusual, and disablement from activity is the rule. Bronchography reveals cylindrical, fusiform, and saccular dilatations, and x-ray examination shows marked signs of parenchymal involvement. The lung in these grave conditions is a sort of foul sponge, draining pus constantly, with constant systemic absorption of toxins causing severe deterioration of general health. The condition is usually multilobar and not un-

commonly bilateral. The mortality rate of lobectomy in these cases is high and the operative prognosis very grave (8). These cases, however, offer an almost hopeless prognosis under medical treatment, inasmuch as the disease is prone to spread to other parts of the lung. It has been reported that a group of such cases under medical treatment revealed a "medical mortality" of 51 per cent when observed during a period of six years (9). These patients have come to the surgeon finally, in desperation, ready to take any risk to attempt to rid themselves of their disease. The mortality rate of lobectomy in these cases, although not as high as in previous years, is still very formidable. Obviously, a statistical statement of lobectomy mortality rate for catarrhal bronchiectasis is not to be accepted as the rate for this condition.

Group 3. In a third group, one places those patients who occupy the middle ground between the first and second classes. As surgical risks they are neither very good, as in the first group, nor very bad, as in the second group. Cough is serious and distressing but the sputum, though at times foul-smelling, is not continuously so, and is not so profuse. They do not present so toxic an appearance and are usually not totally incapacitated for work. Lipiodol bronchography reveals marked and extensive dilatations but the parenchymal involvement on x-ray examination is not nearly so marked as in the second group. Fever and episodes of pneumonitis are occasional. These patients may present a clinical picture of the same degree of infection and the same symptoms for a period of years without marked progression. However, in general these patients almost inevitably progress to the more severe form of the disease (that of the second group) with recurrent parenchymal involvement and spread to other lobes. Episodes of pneumonitis, when they occur, usually signalize increased intensity of symptoms and a progressive deterioration of general conditions. It is rather difficult to distinguish this group from the second group except on the basis of comparative mildness of the degree of anærobic suppurative infection. In this group would be placed those cases of chronic suppurative bronchiectasis secondary to chronic lung abscess which have been operated upon. In these cases the lung abscess has been drained; a bronchocutaneous fistula (single or multiple) is present, cough and expectoration are present, accompanied by fistula drainage in moderate to profuse amounts of the same mucopurulent material. We have treated a series of these cases, referred to us from the thoracic surgical service of Dr. Harold Neuhof, at Mount Sinai Hospital, with the results as appended in the tables of statistics (Tables I–III). It is a justifiable assumption that the outlook in this type is grave, and active measures must be instituted for therapy. Lobectomy in this type of condition

TABLE I.—NON-FOUL CATARRHAL BRONCHIECTASIS

	No.	Percentage
Greatly improved	3	60
Moderately improved	1	20
Unimproved	1	20
	5	

TABLE II.—FOUL SUPPURATIVE BRONCHIECTASIS SECONDARY TO CHRONIC LUNG ABSCESS (OPERATED UPON)

	No.	Percentage
Greatly improved	10	50
Moderately improved	1	5
Unimproved	7	35
Deaths	2	10
	20	

TABLE III.—FOUL SUPPURATIVE BRONCHIECTASIS[2]

	No.	Percentage
Greatly improved	18	45
Moderately improved	7	17.5
Unimproved	7	17.5
Deaths	8	20
	40	

[2] These patients with bronchiectasis and profuse expectoration of large quantities of foul expectoration, although the most seriously ill, have experienced the most benefit and have shown the most striking results and remarkable improvements. In some of these patients, the bronchiectasis involved an entire hemithorax from apex to base, and in some the lesion was bilateral.

(*Note continued on next page.*)

presents a lower mortality rate than in the second group, but has a mortality rate, nevertheless, which is considerably more than that for catarrhal bronchiectasis.

Comment on Classification.—It is clear, in this discussion of the types of bronchiectasis, that the prognosis under medical treatment and the prognosis of cases selected for lobectomy depend entirely upon the type of pathologic lesion present in any given case. To reiterate, to ascertain the value of competing methods, it is fundamentally necessary to have exact information as to the type of case under consideration.

Method of Treatment by Roentgen Therapy.—To secure "control" to the effect of the treatment, absolutely no other form of therapy was used coincidentally. The patients were treated ambulatorily, for the most part, reporting to the Radiotherapy Department as "out-patients." Roentgen therapy was given to these patients over a period of approximately three months, cross-firing all the diseased and secreting lobes (as revealed by thorough bronchography and bronchoscopy) through anterior, lateral, and posterior fields, utilizing three portals for one lobe, or five for the hemithorax, as necessary. The average total dose used was approximately 1,500 r (international units measured in air) through *each* portal of entry. The physical factors of the technic are as follows: from 180 to 200 kv.; focal skin distance, 50 cm.; filter, 0.5 mm. Cu + 1.0 mm. Al; size of the field, 10 × 15 cm. (average). Each treatment consisted of 75 r measured in air to two or three fields.

The patients were usually treated two or three times a week. It was found that at least four months must be allowed to elapse, after a course of therapy had been given, to secure the full measure of improvement. In bilateral cases, it is of advantage to treat both sides simultaneously.

Comment on Results.—The improvement that has been obtained in chronic suppurative bronchiectasis, as the result of roentgen therapy, while moderate in some instances, has been so striking and remarkable in others as to render patients practically cough- and sputum-free.

It is perhaps necessary to emphasize here that the only criterion of improvement that we have employed is decrease in expectoration. It is the sole intention of the therapy to render a secreting "wet" bronchiectasis "dry"; *i.e.*, to secure a symptomatic clinical cessation of the main presenting features of the disease; namely, expectoration and cough. The patients who have obtained great improvement in expectoration and cough and who had experienced hemoptyses and episodes of pneumonitis in the past, have been free of these attacks and episodes subsequent to treatment. Small hemoptyses, such as occur in dry bronchiectasis, have persisted in a few of our greatly improved patients. Clubbing of the digits has subsided surprisingly in a number of cases that have been improved. The mechanism of this is not clear, but subsidence and practical disappearance of the clubbing has been the rule in those patients who have been greatly improved by being freed of the inflammatory symptoms of expectoration and cough. These patients still possess their dilated bronchi, but in being rid of their infection they have reversed the process which brought about the clubbing.

Those patients who have responded well to roentgen therapy, whom we classify as greatly improved, have sustained their improvement during the entire follow-up examination to date—in some cases consisting of a period of over six years. During this period of time, upper respiratory infections have been experienced repeatedly in this group and have been characterized by slight increase in odorless expectoration,

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Reductions in daily expectoration from as high as 30 ounces to one and one-half ounces have been accomplished, with complete loss of foul odor. Cough, previously harassing, has been abolished or reduced to a short morning bout with an expectoration of approximately one ounce. Concomitant with their great symptomatic improvement, some of these patients have lost the clubbing of their fingers. The episodes of pneumonitis have not recurred. Gain in weight and great improvement in color and energy have occurred with the striking clinical improvement of the chronic constitutional septic state.

but without recurrence of harassing cough and profuse foul expectoration.

Follow-up Examination.—The follow-up examination in the greatly improved cases has revealed, thus far, no recurrence in profuse expectoration with repeated upper respiratory infections, and no tendency to resume foul expectoration. These patients who have responded markedly to roentgen therapy are no longer an abhorrence to themselves and others. They appear clinically quite well, arrested to all practical purposes of their previous symptoms. Several of the most severe cases that have experienced great improvement (from 16 to 20 ounces of expectoration reduced to one ounce) have been, as above noted, followed for over six years without recurrence. No cases herein reported are of less than one year follow-up observation. All of our patients have been followed personally and have been examined at frequent intervals.

COMMENT

The prognosis of bronchiectasis is dependent upon the severity of the infection. The mortality of any therapy for bronchiectasis will vary with the degree of suppuration of the involved lobe. Roentgen therapy employed in severe suppurative bronchiectasis, in which lobectomy has a formidable mortality, has produced favorable results in rendering a large percentage of patients clinically arrested (some observed for at least six years) of the symptoms of chronic toxicity, foul expectoration, and cough.

CONCLUSIONS

1. Roentgen therapy in moderate dosage as the sole method of treatment for chronic suppurative bronchiectasis is feasible and successful, resulting in symptomatic improvement in a considerable proportion of cases.

2. The clinical improvement in chronic suppurative bronchiectasis treated with moderately high dosage of roentgen therapy may be so great in some cases as to approach a practically complete cessation of the symptoms of expectoration and cough. These patients now appear clinically well and arrested of their previous symptoms of suppurative bronchiectasis.

3. Follow-up examination, over a period in some instances of six years, in those cases that have been improved has shown no recurrence of symptoms with upper respiratory infections.

BIBLIOGRAPHY

(1) BERCK, M.: Radiotherapy for Bronchorrhea in Bronchiectasis. Jour. Mt. Sinai Hosp., **1,** 98–100, July-August, 1934.

(2) DESJARDINS, A. U.: Action of Roentgen Rays and Radium on the Heart and Lungs: Experimental Data and Clinical Radiotherapy. Am. Jour. Roentgenol. and Rad. Ther., **27,** 149, January; 303, February; 477, March; **28,** 127, July; 271, August; 421, September; 567, October; 699, November, 1932.

(3) BALLON, D. H., and BALLON, H. C.: Diagnosis of Bronchiectasis. Acta Oto-laryngol., **2,** 580, 1927.

(4) SICARD, J. A., and FORESTIER, J.: Methode Generale d'Exploration Radiologique par l'Huile Iodee. Bull. et mém. Soc. med. d. hôp. de Paris, **46,** 463, March 17, 1922.

(5) DESJARDINS, A. U.: Radiotherapy for Inflammatory Conditions. Jour. Am. Med. Assn., **96,** 401–408, Feb. 7, 1931.

(6) LÜDIN, M., and WERTHEMANN, A.: Lungenveränderungen nach Experimenteller Röntgenbestrahlung. Strahlentherapie, **38,** 684–701, 1930.

(7) GRAHAM, E. A., SINGER, J. J., and BALLON, H. C.: Surgical Diseases of the Chest, pp. 575–682. Lea & Febiger, Philadelphia, 1935.

(8) ARCHIBALD, E.: A Consideration of the Dangers of Lobectomy. Jour. Thoracic Surg., **4,** 335–351, April, 1935.

(9) ROLES, F. C., and TODD, G. S.: Bronchiectasis: Diagnosis and Prognosis in Relation to Treatment. British Med. Jour., **2,** 639–643, Oct. 7, 1933.

(10) WALL, C., and Hoyle, J. C.: Observations on Dry Bronchiectasis. British Med. Jour., **1,** 597–602, April 8, 1933.

(11) BERCK, M., and HARRIS, W.: Roentgen Therapy for Bronchiectasis. Jour. Am. Med. Assn., **108,** 517–522, Feb. 13, 1937.

DISCUSSION

MAURICE BERCK, M.D. (New York City): The improvement after therapy usually occurs during the last quarter of treatment and progresses thereafter during a period of from three to four months.

During the course of treatment, the patient's symptoms may be exaggerated, which may lead to discouragement on the part of the patient and also on the part of the therapist. This is a definite part of the radiation effect encountered in the treatment of this disease. Toxicity and cough are more apparent and the patient may run a slight degree of fever. Treatment

may be interrupted if an attack of pneumonitis supervenes.

The first sign of improvement that we notice is loss of fetidity which is accompanied by a decrease in expectoration. There then occurs a concomitant loss of clinical symptoms, a gain in weight, and a loss of clinical toxicity. It is very important to mention this clinical aggravation of symptoms. We have had the experience of learning that in some clinics, where this treatment was used, the therapy was discontinued because the patient was made worse during the course of treatment. I wish to emphasize this phase of the reaction of the patient to this therapy. I should say at least 80 per cent of our patients responded during treatment in like manner. They ran a fever and had an increase in expectoration and cough, at which time they were put to bed. It is not uncommon that a mild case of pneumonitis may be experienced. At this time, of course, the patient should be supported and not subjected to radiation during the height of the pneumonitis.

Clubbing of the Fingers.—I think it is of importance to demonstrate that this is not a permanent phenomenon of bronchiectasis. I have pointed out that clubbing of the fingers, which is well known as a sign of chronic bronchiectasis, subsided in a number of our cases and did not return. The mechanism of this phenomenon is not known. At any rate, we have the clinical picture of a patient rendered clinically well but still with his bronchiectasis, which is now "dry," and disappearance of the clubbing of the fingers.

We realize that in a series of cases over a period of six years now, totalling, in all, 65 cases of totally treated patients, that we cannot present a statistical summary which will be the final picture. We feel we have a chronic inflammatory disease of the lungs, much akin to tuberculosis, under treatment. We realize that any form of therapy which will salvage some of these patients and rehabilitate them economically and socially is worth while. We do not intend to present a statistical figure which will be permanent and which will prophesy what the result in the future will be. It is sufficient to know that we have a certain number of patients rendered clinically well, and who have sustained their improvement over a period of six years. From experience with a much larger series which would come from all over the country, the statistics might be entirely different. We can say that approximately 50 per cent of our patients have experienced great improvement, *i.e.*, are clinically well. We do not use the word "cured." We perhaps would like to use the word "arrested" such as is used in analysis of results of therapy in pulmonary tuberculosis.

Those patients who have been rendered clinically well, have been arrested of the symptoms of cough, toxicity, expectoration, and the general deteriorated state which goes with chronic bronchiectasis. Whether or not they may in the future infect that "dry" bronchiectatic area, is of course beyond our control, except for treatment of foci of infection such as obvious diseases of the throat and paranasal sinuses. It is sufficient to say that we know from the analogy clinically of "dry bronchiectasis" that, once the patient has "dry bronchiectasis," his prognosis is quite benign.[1]

[1] See Reference (10).

DOSAGE AND METHOD OF ROENTGEN THERAPY FOR INFLAMMATORY CONDITIONS[1]

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THE treatment of acute or chronic inflammations with roentgen rays dates back about thirty-five years. During the few years which followed Roentgen's discovery, the possible therapeutic value of the rays was first tested in connection with inflammation of the skin, tuberculous processes such as tuberculous adenitis, and cancer of the skin or of deeper structures. The idea of making such tests arose from the observation of cutaneous or other tissue changes which had occurred after certain diagnostic procedures. Then the action of roentgen rays (or radium) on different kinds of tissue was investigated experimentally, and these investigations rapidly increased our knowledge of the cellular effects of exposure to the rays. As the favorable action of the rays on the pathologic conditions mentioned became known, their therapeutic effect on other conditions was gradually put to the test. Thus it has been found that an increasing number of inflammatory conditions often responds favorably to suitable irradiation.

As early as 1902, Williams included among the pathologic conditions which he had found to respond favorably to roentgen irradiation: herpes zoster, psoriasis, eczema, acne vulgaris and rosacea, prurigo, lichen planus, lupus vulgaris or erythematosus, and tuberculous adenitis or peritonitis. Some of these conditions had been treated with more or less success from one to five years earlier by different physicians, including Freund (1897), Albers-Schönberg (1897–1898), Gautier (1897), Rudis-Jicinsky (1898), Pusey (1900), and several others. According to the competent testimony of the famous French dermatologist, Brocq, who wrote the preface to Belot's important book "Roentgen Therapy for Cutaneous Diseases" (published in 1904), "roentgen therapy already dominates the treatment of skin diseases." Beside the disturbances mentioned by Williams as amenable to roentgen therapy, Belot added sycosis, blepharitis, rhinophyma, and mycosis fungoides. Of course, since we are considering only inflammatory conditions, I shall not mention the early and extensive therapeutic tests made in relation to malignant growths of the skin as well as of other tissues.

It was during the next fifteen years that the treatment of many other forms of inflammation was first investigated. And yet, many present-day radiologists are not even aware of these early investigations and reports, some of which are notable examples of painstaking work and keen observation.

In those early days, much of our present knowledge of the action of roentgen rays on different kinds of cells did not exist. Judged by present standards, the methods of measuring dosage were crude, and the quality of rays then available was limited to wave lengths which could be produced by inferior tubes operating at low electrical potentials. Nevertheless a great deal of the fundamental work was so well done that subsequent investigations could serve only to confirm the results obtained.

Between 1904 and 1910, the main factors which govern the action of roentgen rays on cells were discovered. It was during this same period, as far as the therapeutic effect of roentgen rays on many varieties of inflammation is concerned, that the observation was made that small or moderate doses were sufficient and usually were superior to large doses,

[1] Presented before the Twenty-fourth Annual Meeting of the Radiological Society of North America, at Pittsburgh, Nov. 28–Dec. 2, 1938.

such as those employed in the treatment of most malignant processes. This was especially true in acute inflammations, when a single exposure to a small dose (10 to 50 per cent of the erythema dose) often proved sufficient to arrest the pathologic process. In chronic inflammations, on the contrary, larger but moderate doses (50 to 80 per cent) had to be repeated at intervals for some time in order to cure the lesions or to obtain maximum improvement. At that time, and for many years subsequently, the reasons for these and other variations in the action of the rays were vague and uncertain, and numerous plausible or fanciful explanations were advanced. Even to-day our knowledge of the action of roentgen rays on tissues is far from complete. Nevertheless, it is sufficient to give us a good idea of the main changes which follow irradiation and to enable us to understand, at least in part, many of the effects observed clinically.

How can one account for the fact that a single exposure to a small or moderate dose of rays is usually sufficient to influence favorably an acute inflammatory lesion, and that the same favorable effect can be counted on in a large proportion of cases and in different kinds of inflammation? Moreover, the favorable effect of irradiation is perceptible within a few hours after exposure. Any explanation advanced must rest on adequate and well-controlled experimental observations which have been satisfactorily confirmed, and these observations must agree with the clinical data obtained and recorded by numerous competent observers.

To pathologists it has long been known that one of the prominent features of many forms of inflammation, and especially of acute inflammation, is leukocytic infiltration, the degree of which varies according to the kind of bacteria responsible for the inflammation, and perhaps also according to the number of bacteria present. This is but another way of saying that, when the inflammation is due to bacteria, the degree of leukocytic infiltration varies according to the virulence of the infecting micro-organisms. In a large proportion of cases in which the inflammation is caused by pyogenic bacteria, notably by staphylococci (furuncle, carbuncle, abscess, acute adenitis, etc.), the favorable effect of proper irradiation can be observed within from two to twenty-four hours, and it continues to increase thereafter. If the lesion has been irradiated during the early part of its course, the pain subsides and disappears, although the pain may continue to increase for an hour or two before it begins to diminish. The swelling abates and the lesion gradually undergoes what is known as resolution. When the lesion is irradiated later in its course, the resolving effect of the rays is less striking; pain may diminish just as in the case of lesions which have been treated early, but the analgesic effect takes place somewhat more slowly. A more pronounced effect, however, is that, when the lesion is irradiated after suppuration has started, the suppurative process is hastened and, for this reason, it may become necessary to provide drainage sooner than would be the case with similar lesions which have not been exposed to roentgen rays.

The changes which have been described may be observed in about 75 per cent of the lesions treated. In cases which constitute the remaining 25 per cent, exposure to rays is not followed by any modification which can be recognized as an effect of the rays. This is especially true when the inflammatory process is due to infection by streptococci.

When we try to account for this chain of events, a satisfactory explanation cannot be found until we remember what is known about the great sensitiveness to irradiation of certain varieties of cells, notably the leukocytes (especially lymphocytes, polymorphonuclear neutrophils, and eosinophils). Numerous experiments on animals have long since established the fact that the lymphocytes in lymph nodes, spleen, circulating blood, intestinal follicles, thymus gland, and other structures in which lymphoid cells are to be found, are the most radiosensitive of all the different

kinds of cells in the body. The polymorphonuclear leukocytes and the eosinophils are less sensitive than the lymphocytes, but only slightly less. All three varieties of leukocytes are much more sensitive to irradiation than any other type of cell except the variety of epithelial cell which secretes mucus and which is found chiefly in the salivary glands, stomach and intestine, and bronchi. These mucus-secreting epithelial cells are slightly less sensitive than the lymphocytes and slightly more sensitive than the polymorphonuclear leukocytes and eosinophils, but they seldom play an essential or important part in inflammatory lesions, whereas the three kinds of leukocytes mentioned usually do.

When structures made up largely of lymphocytes are exposed to a small or moderate dose of roentgen rays (or radium), a certain proportion of these cells subsequently undergo degenerative changes and many are destroyed; the degree of this effect, that is, the proportion of lymphocytes thus influenced, depends upon the dose of rays. Moreover, Warthin's experiments showed that this action of the rays begins during irradiation and can be perceived microscopically within half an hour after exposure; in other words, as soon as sections of the irradiated lymphoid structures can be prepared and examined. A small proportion of lymphocytes remains unaffected and serves as a nucleus for subsequent regeneration of these cells, unless excessive or repeated irradiation has destroyed them all. Beginning during irradiation and perceptible soon thereafter, the cycle of cellular changes, as they affect the lymphocytes, increases for two or three days; and then the metabolic activity of the remaining cells (the lymphocytes which were not affected sufficiently to be destroyed) continues at an abnormally low level, especially in relation to mitosis, for from one to three or more weeks. After this, the remaining lymphocytes gradually recover their ability to multiply and, after a time, partial or complete regeneration of these cells takes place. When lymphoid structures are irradiated repeatedly, at relatively short intervals, an increasing proportion of cells is affected, fewer cells are able to survive, and their ability to regenerate and to replace the destroyed cells diminishes more and more, or the cells may disappear completely.

As for the polymorphonuclear and eosinophilic leukocytes in the circulating blood, the degenerative changes induced by irradiation do not become perceptible until from 12 to 24 hours after exposure. A smaller proportion of cells are affected by a given dose, and the resulting cellular changes are similar to those observed in the lymphocytes, although regeneration takes place at about the same time and rate as that of the lymphocytes.

When the affected cells disintegrate, a subsidiary step is that adjacent reticular cells in the lymphoid structures, or in other tissues in the irradiated territory, assume the rôle of phagocytes and ingest the destroyed leukocytes. These reticular macrophages may become quite numerous and, in irradiated inflammatory lesions, they may play an important part in disposing of bacteria and other noxious materials.

In lymphoid structures the lymphocytes destroyed by the rays are replaced by connective tissue, but the proliferation of these cells is slow and does not become apparent until much later. In the meantime, the rapid regeneration of lymphocytes repopulates the lymphoid follicles and tends to mask the increase in connective tissue. It is only after repeated irradiation has brought about marked or permanent disappearance of the lymphocytes that the increase in connective tissue becomes evident. Lymphocytes, polymorphonuclear leukocytes, and eosinophils, destroyed while circulating in the blood, are not replaced by connective tissue; their contents (antibodies, ferments, etc.) are liberated in the blood stream and exert their effects in the same or in some other region.

Now, it is also well known that the degree of leukocytic infiltration in different

kinds of inflammation, or in different cases of the same kind of inflammation, varies considerably. Even in cases of acute infection by staphylococci the degree of leukocytic infiltration varies much in different cases. When the infection is due to streptococci, leukocytic infiltration is often slight and, in the virulent forms of such infection, the number of infiltrating leukocytes in the infected tissues may be small or *nil*. When the infection is diffuse rather than localized, and is caused by virulent bacteria, the leukocytes may not have time to infiltrate the tissues but may elaborate antibodies in the blood stream. Therefore, whatever protective effect the leukocytes may be able to mobilize under these circumstances must be exerted as they circulate through the vessels and capillaries of the infected region.

Anyone who is familiar with the experimental evidence relating to the action of roentgen rays (or radium) on the different varieties of cells, and who tries to correlate and to understand the clinical effects of irradiation, must be struck by one fundamental point of similarity. The rate at which so many acute inflammatory lesions manifest the favorable influence of irradiation corresponds closely to the rate at which normal leukocytes, of the varieties concerned in acute inflammations, are known to be affected by corresponding doses. Could this be a coincidence? Hardly. Those who have attempted to explain on other grounds the action of the rays on acute inflammations have not been successful and have been driven to fanciful and illogical conceptions which do not bear analysis. Beside the many experiments on the action of roentgen rays or radium on normal leukocytes, other experiments on acute inflammations produced experimentally have likewise shown that destruction of leukocytes is a prominent, if not the outstanding, effect of exposure to the rays. The fact that, in a recent series of experiments, Soto, Brunschwig, and Schlutz were unable to observe a similar effect on infiltrating leukocytes may have caused some physicians to wonder why. In irradiating most of their animals, Soto, Brunschwig, and Schlutz used rays generated at 200 kv., filtered through 1 mm. of copper and 1 mm. of aluminium, and usually gave a quantitative dose of 600 r. The results of their experiments would have been much more conclusive if, under similar conditions, they had tested the effect of smaller quantitative doses (one-tenth to one-fourth of the doses employed) and of a less penetrating quality of radiation. Those who have made comparative clinical tests are aware that, in dealing with acute inflammations and many chronic inflammations also, rays generated at 200 kv. are not so effective as rays generated at a lower voltage (from 100 to 150 kv.). This probably is a matter of the proportion of rays absorbed at the level of the lesion. But another important point is the quantitative dose: Against acute inflammations, doses less than 50 per cent of skin tolerance, and sometimes as low as 5 or 10 per cent of skin tolerance, are distinctly more effective than doses beyond this range. It is possible, therefore, that the factors mentioned may explain why, in their experiments, Soto, Brunschwig, and Schlutz did not observe the cellular changes previously reported by others.

When, in acute inflammation, a proportion of the infiltrating lymphocytes, polymorphonuclear cells, and eosinophils is destroyed by the rays, the contents of these destroyed cells, including the antibodies and other protective substances which have already formed, must inevitably be liberated and scattered among the remaining intact cells. Under these circumstances, it seems probable that the protective substances may become even more effective than when they were held within the cells before irradiation. Certainly there is little ground for the assumption that irradiation increases the production of antibodies. On the contrary, the experiments of Hektoen (5–7) and others indicate that irradiation tends to diminish the formation of antibodies.

As far as chronic inflammations are con-

cerned, a satisfactory explanation of the influence of roentgen rays or radium must be based on the pathologic character of the lesions and on the known action of the rays (as disclosed by experiments) on the kinds of cells present in the lesions. When chronic inflammations are considered, leukocytic infiltration plays a less important part, but another, and sometimes a more prominent, feature is proliferation of connective tissue. Besides these two features, the relative proportion of which varies in different forms of chronic inflammation as well as in different cases or stages of the same form, some chronic inflammations are also characterized by varying degrees of central necrosis, caseous degeneration, calcification, or hyaline or amyloid change.

Cells which have already undergone necrosis cannot be influenced by the rays because these cells are already dead. Cheese and chalk, since they are end-products of cellular degeneration, also are impervious to the action of the rays; likewise, hyaline and amyloid material are products of cellular degeneration and should be classed in the same category. As susceptible of being influenced by irradiation, therefore, only infiltrating leukocytes and proliferating connective tissue remain. We are familiar with the great radiosensitiveness of the varieties of leukocytes which usually infiltrate inflamed tissues. In this respect, connective tissue cells, which are relatively resistant to irradiation, provide a sharp contrast. These cells are not affected directly by the doses of rays which ordinarily have the greatest effect on chronic inflammations, but the proportion of connective tissue present may be affected indirectly as a result of the destruction of leukocytes. This indirect increase in connective tissue, however, is comparatively slow. In different kinds or at different stages of chronic inflammation, caused by the same kind of infection or due to some other etiologic factor, the relative proportion of leukocytic infiltration and connective tissue proliferation varies considerably. When leukocytic infiltration preponderates over connective tissue proliferation, this should cause the rays to have a greater and more rapid action on the inflammatory process, and *vice versa*. This is precisely what is observed in practice, as far as clinical observation allows. When the lesions have not been present a long time, they are distinctly more amenable and respond to treatment more rapidly than when they are of long standing and the leukocytic infiltration has been replaced by connective tissue to a greater extent. Moreover, the considerable, though varying, proportion of these two factors in all chronic inflammations probably explains why such inflammations respond to treatment so much more slowly than acute inflammations, why larger quantitative doses of rays are necessary, and why, if satisfactory results are to be obtained, the treatment must be repeated at intervals for some time.

METHOD

If the considerations which have been set forth are as valid as they appear to be, what influence should they have on the method of irradiation?

The first and most important point is that, when dealing with inflammatory conditions, whether acute or chronic, the concept of maximum, tolerance, or tumor doses must be abandoned. Not only are they less effective, but they are actually dangerous. In treating most malignant tumors, it is essential that the neoplasm should receive the maximum dose which can be delivered to it without undue injury to overlying or surrounding normal tissues. To follow this principle in treating inflammatory conditions would be a waste of electrical energy, a gross waste of time on the part of the personnel as well as of the patient, and an unwarranted increase in cost. But, still more important, there would be danger of inducing in the affected tissues an inflammatory reaction independent of that which is already present, and this might readily lead to spread rather than resolution of the infection. The

principles of sound treatment would thus be violated. This probably explains why some radiologists have failed to obtain the favorable results which should follow proper treatment. But the possibility of spreading the infection by excessive doses is not the only danger. Experiments on animals, carried out by Lacassagne and Vinzent, have shown that, when acute inflammatory lesions induced by injecting *Streptobacillus caviæ* into rabbits were exposed to doses of roentgen rays such as are used in the treatment of malignant processes, a considerable proportion of the animals subsequently developed sarcomas in the same region.

For acute inflammations, especially those due to infection by staphylococci or to trauma, experience has shown that a single, small dose (from 10 to 50 per cent of the erythema dose) is usually sufficient and yields the best results. Occasionally, when a single exposure has not had the desired effect, a second exposure several days after the first may be worth trying. For example, the first dose may result only in partial resolution, and a second dose may be necessary to complete the effect. The more acute the inflammation, the smaller the dose usually required.

An important point is that the field of irradiation should not be confined too closely to the visible limits of the inflamed area, but should include a wide zone of apparently normal tissues. This deserves more attention than it frequently receives and is especially true when the inflammation has been caused by virulent bacteria, such as streptococci or *Bacillus welchii*. Here, because the limits of infection are often uncertain, because leukocytic infiltration often is slight or practically non-existent, and because it is essential to have the rays act on leukocytes in the blood circulating through the inflamed region and all around it, the advantage of treating widely cannot be stressed too much. When a patch of erysipelas covers one cheek, for instance, the entire side of the head and a good part of the neck should be included in the field of irradiation.

In treating inflammations caused by highly virulent bacteria such as *Bacillus welchii*, Kelly (8-11) has found advantage in using small doses and repeating them daily or twice daily for several days. The reason why such a procedure should be more effective is not clear. It is possible that when the infecting bacteria have a high degree of virulence, a single irradiation may not influence a number of circulating leukocytes sufficient to overcome the infection. But when irradiation is repeated daily or twice a day for three or four days, the number of circulating leukocytes acted on by the rays must necessarily be much greater, and this may possibly account for the greater efficacy of Kelly's method in the treatment of this kind of infection. Inasmuch as streptococcic infections often assume a virulent form, and leukocytic infiltration is often slight or wholly lacking, it is possible that the same method of small doses repeated daily or twice daily for three or four days might have a similar advantage.

As far as the quality of the rays is concerned, there seems to be little doubt that rays generated at moderate voltage such as from 100 to 150 kv. (the "New Dealers" in radiology would now call this "low" voltage) and filtered through 4 or 6 mm. of aluminium or through copper of equivalent filtration value, are more effective than rays generated at 200 kv. or more. In all probability, the superiority of rays of medium wave length is due largely to the greater absorption of these rays by the inflamed tissues, and, perhaps, to a difference in the scattering factor also influencing absorption. Whether or not these related factors constitute an adequate explanation remains to be determined.

When roentgen rays (or radium) are employed in the treatment of chronic inflammations, as I have already mentioned, larger, though still moderate doses (50 to 80 per cent of erythema), must be repeated at intervals for some time in order to cure the lesions or to obtain maximum improve-

ment. Needless to say, the intervals between successive irradiations must be governed by the dose given at each session. If a dose corresponding to two-thirds or three-fourths of the quantity required to induce erythema is selected, an interval of from two to four weeks would probably be found the best. At least, this has been our experience. How many times the treatment should be repeated depends on the kind of inflammation and on the rate at which the lesions of each patient may respond. Since these factors vary considerably in different cases, a predetermined number cannot be set. In chronic infectious arthritis, irradiation every three or four weeks from two to four times may be sufficient to cause the inflammation and the patient's symptoms to subside completely or to yield as much as they will. In tuberculous adenitis or tuberculous inflammation of joints, irradiation every three or four weeks may have to be continued for from three to twelve months, or even longer.

One consideration cannot be stressed too much, and the inability of some radiologists to obtain satisfactory results is often due to their failure to realize its importance. This is that, in chronic inflammations generally, treatment must not be discontinued too soon. Even after the lesions and symptoms have disappeared, or have ceased to be active, it is wise to treat the patient once or twice more. The more chronic the lesion, the more essential is this precaution. As examples I need only cite tuberculous adenitis, peritonitis, arthritis, or synovitis. The response of tuberculous lesions to roentgen irradiation varies considerably from one patient to another, but, in general, it is characteristically slow. When treatment is stopped too soon, what might have been an excellent and permanent result is spoiled; after a period of apparent arrest, the tuberculous process becomes active again, and resumption of treatment may not be as effective as before. Greater persistence in the first instance is usually the best policy.

REFERENCES

(1) ALBERS-SCHÖNBERG: Beitrag zur therapeutischen Verwendung der Röntgenstrahlen in der Behandlung des Lupus. Fortschr. a. d. Geb. d. Röntgenstrahlen. **1,** 72–75, 1897, 1898.

(2) BELOT, JOSEPH: La radiothérapie, son application aux affections cutanées, 520 pp. G. Steinheil, Paris, 1904.

(3) FREUND, L.: Ein mit Röntgen-Strahlen behandelter Fall von Naevus pigmentosus pilferus. Wien. med. Wchnschr., **47,** 428–434, 1897.

(4) GAUTIER: Traitement de l'acne et de la couperose par les rayons X. Comptes-rendus du XII. Cong. Internat. d. med., pp. 382–385, 1897.

(5) HEKTOEN, LUDVIG: The Influence of the X-ray on the Production of Antibodies. Jour. Infect. Dis., **17,** 415–422, September, 1915.

(6) Idem: Further Studies on the Effects of the Roentgen Ray on Antibody Production. Jour. Infect. Dis., **22,** 28–33, 1918.

(7) Idem: Further Observations on the Effects of Roentgenization and Splenectomy on Antibody Production. Jour. Infect. Dis., **27,** 23–30, 1920.

(8) KELLY, J. F.: The X-ray as an Aid in the Treatment of Gas Gangrene. RADIOLOGY, **20,** 296–304, April, 1933.

(9) Idem: The Present Status of the X-ray as an Aid in the Treatment of Gas Gangrene. RADIOLOGY, **26,** 41–44, January, 1936.

(10) KELLY, J. F., and DOWELL, D. A.: Present Status of the X-rays as an Aid in the Treatment of Gas Gangrene. Jour. Am. Med. Assn., **107,** 1114–1117, Oct. 3, 1936.

(11) KELLY, J. F., DOWELL, D. A., RUSSUM, CARL, and COLIEN, F. E.: The Practical and Experimental Aspects of the Roentgen Treatment of *Bacillus welchii* (Gas Gangrene) and Other Gas-forming Infections. RADIOLOGY, **31,** 608–619, November, 1938.

(12) LACASSAGNE, A.: Tumeurs malignes provoquées, chez le lapin, par l'irradiation de foyers inflammatoires. Compt. rend. Acad. d. sci., **196,** 69–71, 1933.

(13) Idem: Conditions dans lesquelles ont été obtenus, chez le lapin, des cancers par action des rayons X sur des foyers inflammatoires. Compt. rend. Soc. de biol., **112,** 562–564, 1933.

(14) Idem: Cancers Produced in Rabbits by the Action of X-rays upon Inflammatory Lesions. British Jour. Radiol., **6,** 689–691, November, 1933.

(15) LACASSAGNE, A., and VINZENT, R.: Action des rayons X sur un foyer infectieux local, provoqué chez le lapin par l'injection de *Streptobacillus caviæ*. Compt. rend. Soc. de biol., **100,** 247–249, 1929.

(16) Idem: Sarcomes provoqués chez des lapins par l'irradiation d'abcès à *Streptobacillus caviæ*. Compt. rend. Soc. de biol., **100,** 249–251, 1929.

(17) PUSEY, W. A.: Lupus Healed with Roentgen Rays. Jour. Am. Med. Assn., **35,** 1476–1478, Dec. 8, 1900.

(18) RUDIS-JICINSKY, J.: Lupus Treated by X-rays. Am. X-ray Jour., p. 423, 1898.

(19) SOTO, J. A., BRUNSCHWIG, ALEXANDER, and SCHLUTZ, F. W.: An Experimental Study of the Effects of X-radiation upon Acute Pyogenic Infection of the Skin and Subcutaneous Tissues. Surgery, **3,** 593–600, April, 1938.

(20) WARTHIN, A. S.: An Experimental Study of the Effects of Roentgen Rays upon the Blood-forming Organs, with Special Reference to the Treatment of Leukemia. Internat. Clin., s. 15, **4,** 243–277, 1906.

(21) WILLIAMS, F. H.: The Roentgen Rays in Medicine and Surgery as an Aid in Diagnosis and as a Therapeutic Agent. Ed. 2, 757 pp. Macmillan Co., 1903, New York.

DISCUSSION

PAUL D. MOORE, M.D. (Muncie, Indiana): This symposium has been informative and stimulating, but I believe I have not heard any of the speakers mention the x-ray treatment of streptococcic septicemia. I refer to cases that are medicine-fast, resisting medical treatment.

Your minds quicken with a sense of familiarity upon recalling your own cures of such streptococcal infections as erysipelas, acute otitis media, acute mastoiditis, and even streptococcal pneumonia following roentgen therapy. I have treated all of these conditions successfully and the hospital staff refers such cases to me with enthusiasm. It would be useful to check results against the specific strain of the organism. My cases were mostly due to *Streptococcus hemolyticus*. It is possible that the rarer types, such as *S. viridans* and *S. putridus*, may not respond, but we still have this to learn.

Since the few patients I have treated do not warrant a statistical comparison, case reports must suffice to give you a clinical impression. A female, 15 years of age, entered the hospital with temperature 103.5° and bilateral acute otitis media of two weeks' duration. Mastoid radiographs revealed non-development of cellular structure. A myringotomy was performed but septicemia and bilateral pneumonitis developed. Radiographs revealed diffuse parenchymal involvement of both lungs, and blood cultures were positive for hemolytic streptococci.

In spite of large doses of sulphanilamide, Congo Red and even Cadham's hyperimmune rabbit serum from Winnipeg (which reputedly yields 90 per cent cures), the patient steadily became worse. Consultants from the University Medical Center indicated a fatal outcome and when I was called at the end of four weeks to see the patient the relatives also were called for presence at the death.

The mobile unit at the bedside was used to deliver through the cellophane of the oxygen tent 75 r in air, over the chest, in one treatment. In 15 hours improvement justified removing her from the oxygen tent and treating each ear with 100 r of x-ray. An uneventful recovery followed and she has been normally well for this past year. The pneumonia, septicemia, and bilateral otitis all healed completely.

Without making any claims on the basis of a few cases, I report on an adult male whom I treated, in 1932. He had a bilateral acute mastoiditis which had been treated surgically. The complication of lateral sinus thrombosis, although treated by surgical intervention, failed to cure or prevent a hemolytic streptococcic septicemia from developing. Positive blood cultures were recorded daily. Transfusions of blood, surgical drainage of very deep multiple abscesses, and exceedingly good private nursing failed to revive the patient. Consultation from the University Medical Center was obtained and the patient was sent for x-ray therapy in a condition of cachexia, profound anemia, and stupor.

One hundred roentgens in air over the spleen and over the liver was given, bearing in mind the effect on the reticuloendothelial system. The method was experimental and the dose arbitrary. The next day the patient spoke. He at least was not worse and we were encouraged to treat him daily in the manner just mentioned. At the end of seven days the blood culture was negative and in another week he had a dinner party with friends. The recovery was uneventful except for a mild infectious arthritis of one shoulder, which responded to physical therapy. The patient is living to-day and perfectly well.

I hope these cases will stimulate those of you who have access to numerous patients of this type to make a statistical study, including a study of the type of streptococcus. Certainly in a large group of cases there will be a percentage of failures. For instance, one patient with streptococcic septicemia failed to respond to Cadham's hyperimmune rabbit serum and sulphanilamide therapy. She had already developed a brain abscess. Under

no circumstances did her fever drop in spite of good medication and care. The only time the temperature reached normal was the day following an x-ray treatment. She was transported to another hospital for surgical intervention of the brain abscess, and died.

As I said before, I refer to medication-resistant cases of streptococcic septicemia, especially hemolytic. If the primary lesions were treated early with x-ray, then the secondary septicemia and its complications could be prevented. Simultaneous chemotherapy is not contra-indicated and is an extra safeguard, but is often unnecessary.

EFFICIENCY CURVES IN QUANTITATIVE RADIOBIOLOGY

By WILLIAM H. LOVE, B.Sc., PH.D., University of Sydney, *Sydney, Australia*

IF the characteristics of the tissue and the physical conditions of the irradiation are known, it is possible to plot two related sets of curves, the one showing the correlation between the quantitative biological effect M and the variable irradiation time t for constant radiation doses q_A, q_B, q_C, ..., and the other showing the correlation between M and the variable radiation intensity α for the same radiation doses.

When an attempt is made to draw these curves for the most general case of any irradiated tissue several complexities are encountered, but if we exclude the most rapidly proliferating tissues (I), they can be constructed without great difficulty.

By employing the results obtained in an earlier publication (1), it can be shown that the curves cannot cut, and that they can be generally represented as in Figures 1 and 2, in which T represents the duration of the radio-sensitive period (I).

These results, analytically obtained, are particularly instructive and appear to be consistent with all the experimental work that has been done in this field.

Reference to Figure 1 shows that some of the curves exhibit maximum values which drift progressively in the direction of increasing time as the radiation dose is increased (1). Other curves (q_A, etc.) in the same family show that M falls continuously as t increases, and one particular curve (q_M) exhibits the complete independence of M and t over a particular range of t.

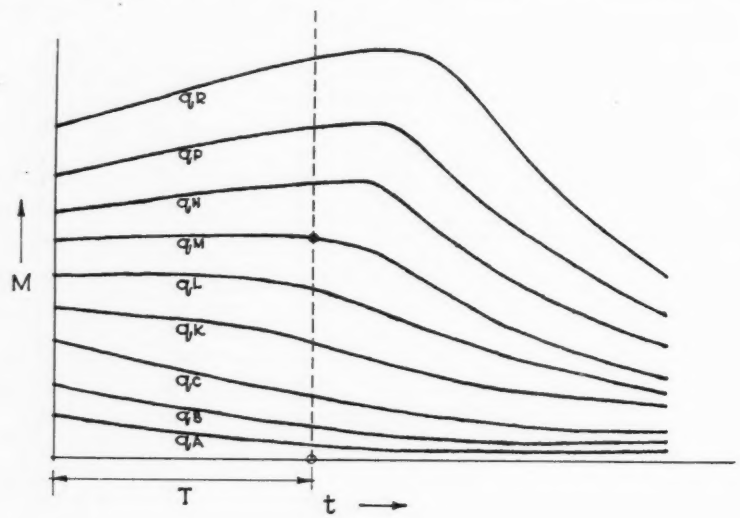

Fig. 1.

From Figure 2 we see that the critical intensity, *i.e.*, that intensity with which is associated maximum biological effect for a given dose, is in general a function of the radiation dose, that in certain circumstances it may vary slowly with the dose, and that it may even be independent of the dose (1). The maxima in this case drift progressively in the direction of decreasing intensity as the radiation dose is increased, and it can be shown that the maximum possible range of variation in the critical intensity is q^1_L to q^1_M, these

latter quantities being determined by the characteristics of the tissue.

The practical importance of realizing the significance of the several other symbols[2] being clearly indicated in Figures 3 and 4.

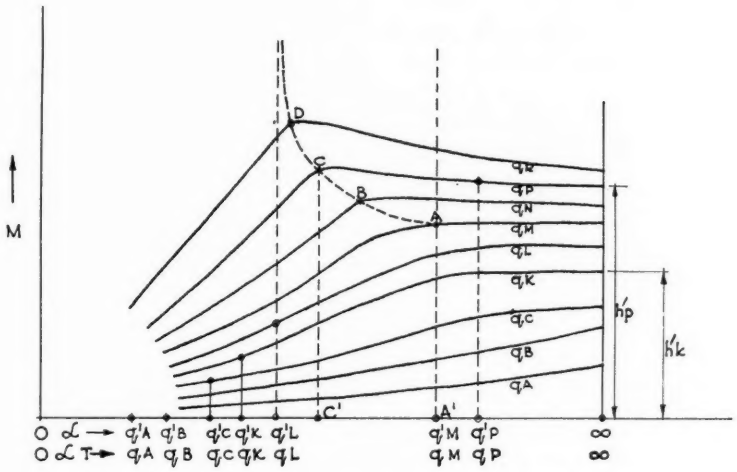

Fig. 2.

the critical intensity is seen to vary with the dose, and a quantitative estimate of the effect of a given departure from the critical intensity can be easily obtained.

If, as in a previous publication (2), the mortality curve[1] is represented by $Q = f(q)$ (Figs. 3 and 4), then the resultant mortality sustained by a tissue irradiated with a dose q_1, at a rate α, is given by

$$M_1 = \frac{\partial N}{\partial t} \cdot T \left\{ \frac{2A_1}{q_T} - \left(\frac{q_1}{q_T} - 1 \right) h_1 \right\} \quad (1)$$

when

$$q_T = \alpha T > q_1$$

and by

$$M_1 = \frac{\partial N}{\partial t} \cdot T \left\{ \frac{2A_T}{q_T} - \left(\frac{q_1}{q_T} - 1 \right) h_T \right\} \quad (2)$$

when

$$q_T = \alpha T < q_1$$

[1] The mortality curve exhibits the relationship between the dose q and the fractional mortality, or the fractional biological effect Q.

If α is the critical intensity for a dose q_1 we have

$$-2A_T + 2q_T h_T - q_1 h_T + q_T(q_1 - q_T) \frac{\partial h_T}{\partial q_T} = 0 \quad (3)$$

and as q_1 increases indefinitely α approaches the value determined by

$$\left(\frac{\partial h_T}{\partial q_T} \right)_{q = q_L} = \frac{h_L}{q_L} \quad (4)$$

a result which can be interpreted in relation to Figure 5, in which OT is the tangent from the origin, and OM the line with which the curve forms segments of equal area.

It follows from this that the curve connecting the several maxima in Figure 2 is asymptotic to q'_L where

$$q'_L \cdot T = q_L \quad (5)$$

and it can also be shown that

[2] $\frac{\partial N}{\partial T}$ in the case considered here is a constant.

$$q^1{}_M \cdot T = q_M \qquad (6)$$

It is convenient to call αT the partial dose for any intensity α, and if we plot the mortality against partial dose (Fig. 2), several significant relationships are immediately established, and further simplifications are introduced into the subsequent analysis.

If, as previously, we define the biological efficiency E as the ratio between the mortality and the radiation dose, it becomes clear that Equations 4 and 5 define the intensity with which is associated maximum biological efficiency on the primary mortality curve.

From Equations 1 and 2 we get

$$E_1 = \frac{M_1}{q_1} = \frac{\partial N}{\partial t} \cdot \frac{T}{q_1 q_T} \{2A_1 + (q_T - q_1)h_1\} \qquad (7)$$

when

$$q_T > q_1$$

and

$$E_1 = \frac{M_1}{q_1} = \frac{\partial N}{\partial t} \cdot \frac{T}{q_1 q_T} \{2A_T + (q_1 - q_T)h_T\} \qquad (8)$$

when

$$q_T < q_1$$

If we now write

$$E_1 = f(q_1, q_T)$$

it will be seen that this function is symmetrical in q_1 and q_T, *i.e.*, $f(q_1, q_T) = f(q_T, q_1)$ from which it follows that the curves E_1, q_1 obtained by ascribing to q_T a series of constant values, q_A, q_B, q_C, etc., are identical with the curves E_1, q_T, obtained by ascribing the same constant values to q_1. In other words, total dose and partial dose are interchangeable in the above sense

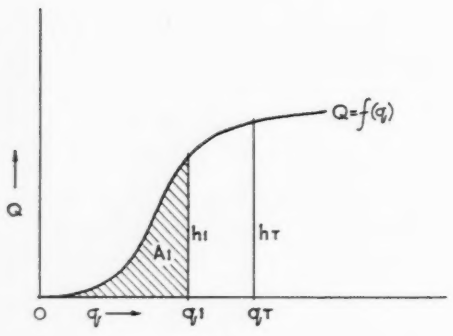

Fig. 3.

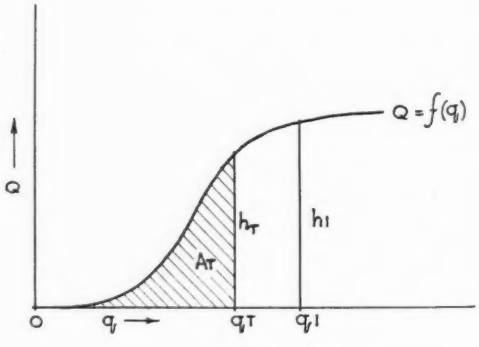

Fig. 4.

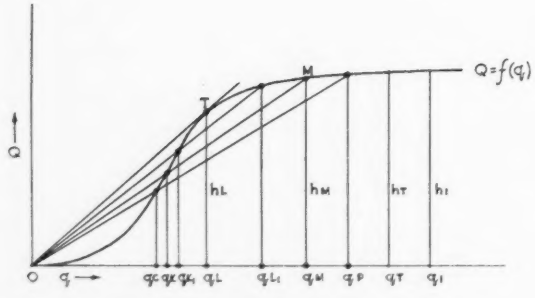

Fig. 5.

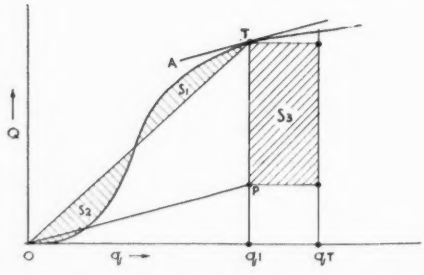

Fig. 6.

We can now go on to show that

$$\frac{\partial E_1}{\partial q_1} = -\frac{\partial N}{\partial t} \cdot T \cdot \frac{2}{q_T {q_1}^2} \left\{ S_1 - S_2 + \frac{S_3}{2} \right\} \quad (10)$$

when

$$q_T > q_1$$

and that

$$\frac{\partial E_1}{\partial q_1} = -\frac{\partial N}{\partial t} \cdot T \cdot \frac{2}{q_T {q_1}^2} \{ S_1 - S_2 \} \quad (11)$$

when

$$q_T < q_1$$

S_1, S_2 and S_3 being the areas shown in Figures 6 and 7 and OP being the parallel to AT the tangent at T in Figure 6.

When these results are considered together in relation to Figures 2 and 5, it will be found that

(1) If $q_T = q_P > q_M$ the efficiency increases with q_1 to a maximum value $\frac{cc^1}{q_P}$ which is realized for some particular value of the partial dose, between q_L and q_M, then decreases to a limiting value $\frac{h_P}{q_P} \cdot \frac{\partial N}{\partial t} \cdot T$. As q_T increases, the partial dose determining the position of the maximum approaches q_L.

(2) If $q_T = q_M$ the efficiency increases with q_1 to a maximum value $\frac{AA^1}{q_M}$ which is realized when $q_1 = q_M$ and then remains independent of q_1.

(3) If $q_T = q_K < q_M$ the efficiency in-

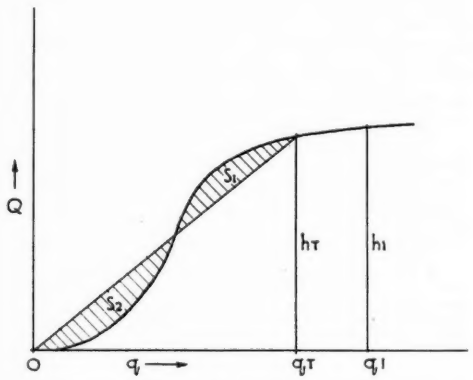

Fig. 7.

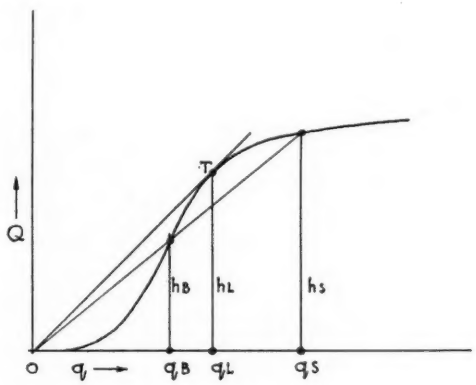

Fig. 8.

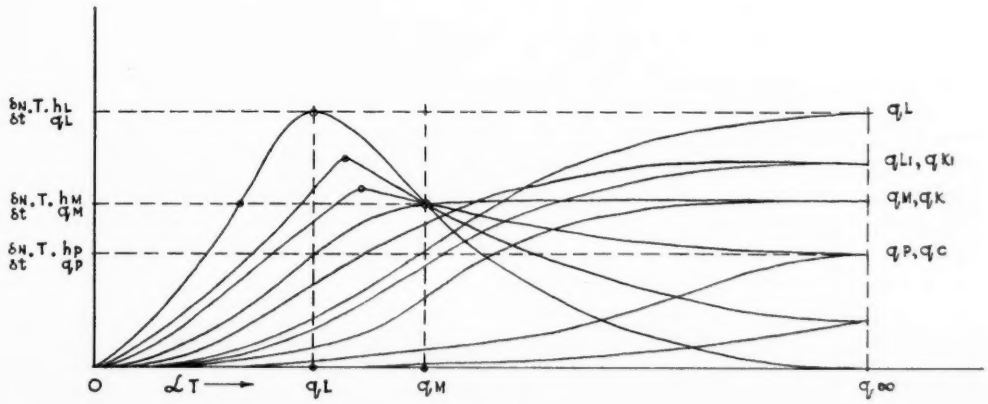

Fig. 9.

creases continuously with q_1 to a limiting value $\frac{h_K}{q_K} \cdot \frac{\partial N}{\partial t} \cdot T$.

If $h^1{}_K$ and $h^1{}_P$ are the limiting ordinates for infinite intensity on the mortality intensity curves q_K and q_P (Fig. 2), we see that

$$h^1{}_K = h_K \frac{\partial N}{\partial t} \cdot T$$

and

$$h^1{}_P = h_P \cdot \frac{\partial N}{\partial t} \cdot T$$

and in virtue of the obvious property (Fig. 8)

$$\frac{h_B}{q_B} = \frac{h_S}{q_S}$$

which must exist for pairs of points on either side of T, it is clear that pairs of efficiency curves pass to the same limits, which are all less than $\frac{h_L}{q_L} \cdot \frac{\partial N}{\partial t} T$.

We will now investigate the variation in the maximum efficiencies associated with the critical intensities, that is to say, along the curve A B C D. . . . (Fig. 2).

The condition that a critical intensity exists is that the total dose q_1 must be greater than q_M, and if this condition is satisfied the partial dose q_T, which determines the critical intensity, is given by equation (2), which, when combined with equation (8) leads to

$$E_{1(\max.)} = \frac{\partial N}{\partial t} \cdot T \left\{ \frac{h_T}{q_1} + \left(1 - \frac{q_T}{q_1}\right) \frac{\partial h_T}{\partial q_T} \right\} \tag{12}$$

It can be shown that

$$\frac{\partial}{\partial q_1} \{E_{1(\max.)}\} = \left\{ \left(1 - \frac{q_T}{q_1}\right) \frac{\partial^2 h_T}{\partial q_T{}^2} \cdot \frac{\partial q_T}{\partial q_1} + \frac{1}{q_1{}^2} \left(q_T \frac{\partial h_T}{\partial q_T} - h_T \right) \right\} \tag{13}$$

and substituting the value

$$\frac{\partial q_T}{\partial q_1} = \frac{h_T - q_T \frac{\partial h_T}{\partial q_T}}{q_T(q_1 - q_T) \frac{\partial^2 h_T}{\partial q_T{}^2}} \tag{14}$$

we find

$$\frac{\partial}{\partial q_1} \left\{ E_{1\,(\max.)} \right\} = \left(\frac{q_1 - q_T}{q_1} \right)^2 \frac{\partial^2 h_T}{\partial q_T{}^2} \cdot \frac{\partial q_T}{\partial q_1} \tag{15}$$

which is clearly positive and E_1 (max.), therefore, increases with q_1, and approaches the limiting value

$$\frac{h_L}{q_L} \cdot \frac{\partial_N}{\partial_E} \cdot T.$$

We are now in a position to construct the efficiency curves which are shown in Figure 9. In this system of curves partial dose and total dose are interchangeable in the sense previously established, the significance of the several symbols in relation to the primary mortality curve being clearly shown in Figure 5.

It will be observed that the intensity or partial dose with which maximum efficiency is associated tends to become independent of the dose as this increases (1). The partial dose approaches q_L, namely, that partial dose with which is associated maximum efficiency on the primary mortality curve, and the efficiency approaches the maximum possible value $\frac{h_L}{q_L} \cdot \frac{\partial N}{\partial t} \cdot T$. The efficiency for any other partial dose q_S, likewise, approaches $\frac{h_S}{q_S} \cdot \frac{\partial N}{\partial t} \cdot T$.

These latter results are a direct consequence of the fact that, for any fixed partial dose, the mortality sustained by cells in the radiosensitive condition at the commencement of the irradiation, becomes small compared with that sustained by cells which are subsequently irradiated.

BIBLIOGRAPHY

(1) British Jour. Radiol., **10**, 38–45, January, 1937.
(2) British Jour. Radiol., **6**, 387, 1933.

ROENTGENOGRAPHIC IMAGES IN PRIMARY CARCINOMA OF THE LUNG

By LEW A. HOCHBERG, M.D., C.M., *Brooklyn, New York*

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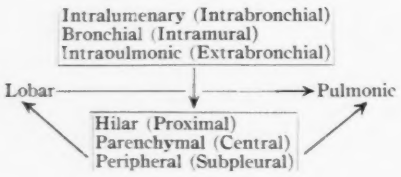
IT would not be pleonastic to reiterate that the co-operative efforts of the internist, roentgenologist, bronchoscopist, pathologist, and thoracic surgeon have contributed immeasurably to our rapid advancement in the study of carcinoma of the lung. Without such teamwork there would have been relatively little progress in attaining an earlier recognition of this disease. These endeavors have undoubtedly popularized this disease and may, in a large measure, account for the current beliefs that there is an increase in the incidence of primary carcinoma of the lung.

As early as 1910, Otten showed that there were two forms of malignant neoplastic disease of the lung. Several years later, Assmann was able to subdivide pulmonary carcinomas into six roentgen forms. About this same time Tovell showed that there was a relationship between the type of lesion and the roentgen-ray picture. In more recent times, Kirklin and his co-workers have again considered carcinoma of the lung to be of two primary forms, namely, bronchial and parenchymal. Hyde and Holmes prefer to classify bronchogenic carcinomas as obstructive and non-obstructive; Rabin and Neuhof suggest that they be classified as circumscribed and non-circumscribed. Wasch and Epstein believe that the clinico-roentgenographic subdivision should be on the basis of the degree of progress of the lesion and they, therefore, subdivide bronchogenic carcinomas into early, moderately advanced, and far advanced.

The writer proposes a roentgenographic classification of primary carcinoma of the lung which is based upon the pathologic changes within the lung. This classification recognizes three modes of growth: (1) In which the tumor is *intralumenary* (intrabronchial) and produces roentgen changes characterized by bronchial obstruction; (2) the *bronchial* (intramural) which is characterized by a carcinomatous extension along the lymphatics of the bronchial tree, and (3) an *intrapulmonary* (extrabronchial) form in which the neoplasm grows outside the lumen of the bronchus and extends around it, forming a peribronchial mass within the lung tissue. Regardless of whether or not the growth extends into the lumen of the bronchus, along the wall of the bronchus, or outside the bronchus, the site of origin is either at the *hilum*, in the *parenchyma*, or at the *periphery* of the lung. The roentgenographic changes associated with a carcinoma of the lung will, therefore, depend upon the location of the primary growth, its size, mode of growth, effect upon the neighboring structures, and the secondary changes within the lung incidental to the expansion of the neoplasm.

There is no roentgen picture pathognomonic of carcinoma of the lung. It is only after considering the history and clinical course that we may venture an opinion as to whether or not a roentgen film is suggestive of pulmonary neoplastic disease. Thus, a massive pleural effusion may hide an underlying process which may or may not be carcinomatous; an aspirated foreign body or a polyp within the bronchus may produce a massive collapse of the lung simulating an obstructing carcinoma of the bronchus; a solitary metastatic hypernephroma may have many of the characteristics of a parenchymal carcinoma; enlarged hilar glands due to Hodgkin's disease or an aortic aneurysm may be mistaken for a hilar bronchogenic carcinoma. However, with the aid of the history and clinical course, the interpretation of roentgenographic studies should be considerably simpler. The proposed

classification[1] may be represented schematically as follows:



Hilar.—In this type, the primary growth arises from the bronchus at, or near, the root of the lung. The bronchus at this site has a wide lumen, therefore, an intrabronchial growth in this region must attain considerable size before it can obstruct the bronchus and produce a massive atelectasis. At its inception, a hilar neoplastic process cannot be detected by roentgenography. It is not surprising, therefore, that in the earliest stages the growth will escape recognition. When, however, it has increased in size, or has extended to the hilar lymph nodes, it may be recognized by the regional opacity. This area presents a unilateral, hilar, and more or less homogeneous infiltration (Fig. 1). At this early stage, the primary growth need not be visible on the roentgenogram. The size of the shadow varies with the duration of the disease, the rate of growth of the neoplasm, and the rate at which the lymphatics and pulmonary tissue become involved. The shape of the opacity is semicircular or triangular, with its convexity or base directed toward the lung tissue on the side of the neoplasm.

Stivelman pointed out that an endobronchial tumor may extend through the wall of the bronchus and infiltrate the tissues in the region of the hilus, *via* the lymphatics, and form nodular, glandular growths along the bronchial wall. As the mother tumor increases in size (still not obstructing the bronchus), the regional lymph nodes continue to increase in size and cast a unilateral shadow, which, together with the neoplasm, remains fairly well demarcated from the surrounding lung tissue. The edges of the solid mass and surrounding lung parenchyma frequently will show infiltrative, radiating projections and congestive changes (Fig. 2). At this stage, the growth is generally of an uneven radiolucency, and may appear lobulated with a nodular or irregular lateral border. The opacity is due to the tumor, glands, and reactionary changes, no one of which can be distinguished from the other. The proximal part of the infiltration is usually confined to the level between the fifth and ninth dorsal vertebræ. Oblique and lateral roentgenographic studies may show a retrocardiac or mediastinal opacity (Fig. 3). If the tumor and glands have attained an appreciable size, the heart may be displaced anteriorly or rotated away from the affected side.

As the intrabronchial tumor increases further in size, and an intramural lymphatic spread of the disease takes place, the mucosa becomes congested, edematous, and pressed upon from without. As a result of the inflammatory and neoplastic changes within the lung, superimposed upon the condition within the bronchus, the latter soon becomes obstructed, and atelectasis ensues. The extent of the atelectasis depends on the size of the bronchus occluded, and may, therefore, be massive, when the main bronchus is affected (Fig. 4), or lobar, when a stem bronchus is occluded (Figs. 5 and 6). In those instances in which atelectasis has taken place, there is a more or less uniform opacity of the lung or lobe with diminished opacity toward the peripheral part of the lung-field; the intercostal spaces are narrowed, the diaphragm is elevated, and the mediastinum may be somewhat retracted toward the affected side. Frequently, the mediastinum is fixed, due to the surrounding inflammatory changes secondary to the neoplastic process, in which instances the mediastinum will not be displaced.

[1] This classification recognizes the site of origin in all cases of carcinoma of the lung, as the bronchus or some subdivision thereof.

The roentgenogram in the early extrabronchial or intramural hilar type of neoplasm is essentially the same as that of the intrabronchial type. In the extrabron-

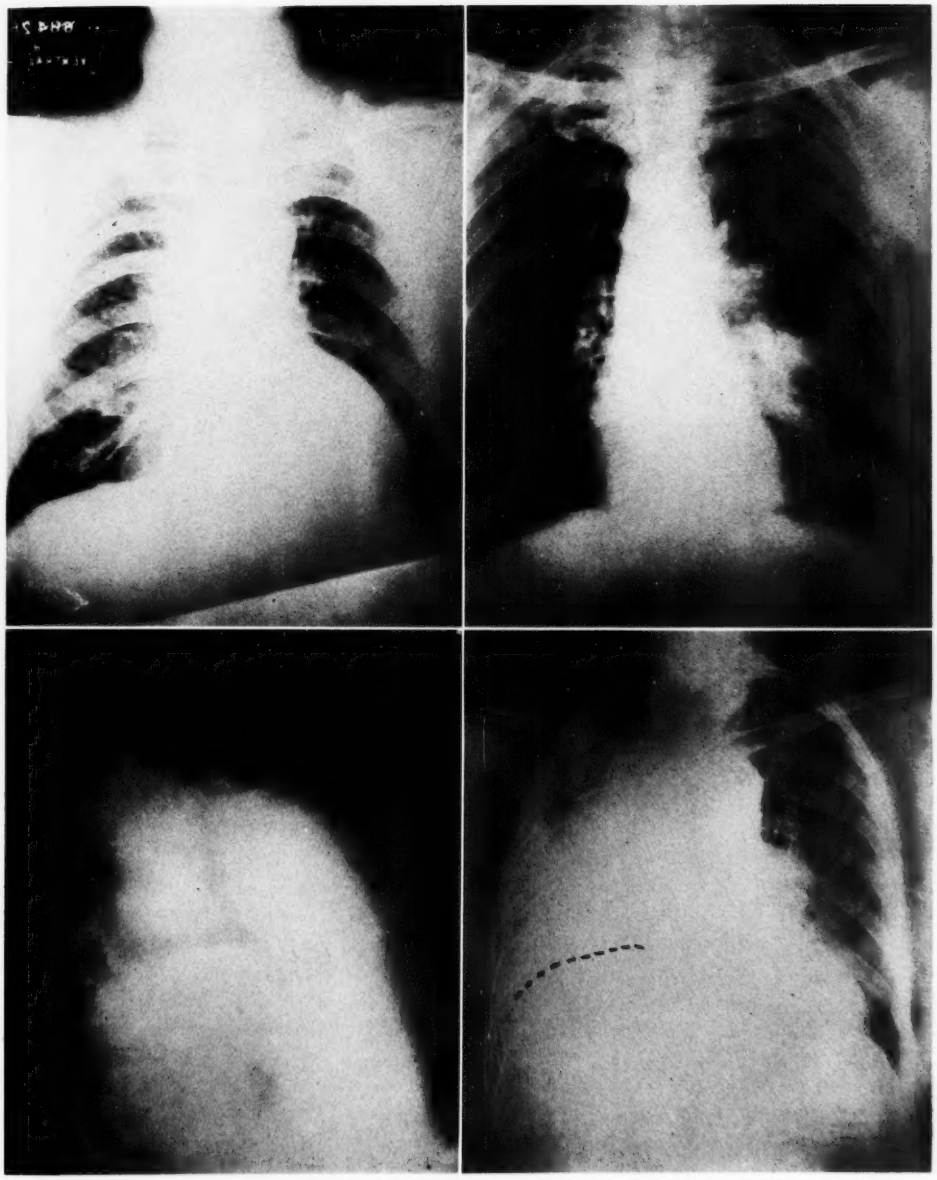


Fig. 1 (*upper left*). Unilateral (right) hilar glandular enlargement with some infiltration of the proximal part of the lung parenchyma.

Fig. 2 (*upper right*). Bilateral hilar glandular enlargement, more pronounced on the left. Note the irregular mottled appearance of the left hilar opacity and its irregular distal edge.

Fig. 3 (*lower left*). Lateral view of the chest in a patient in whom the anteroposterior view showed only a suspicious infiltration jutting out from behind the heart. There is a dense retrocardiac opacity.

Fig. 4 (*lower right*). Atelectasis of the right lung. The right hemithorax appears smaller than the left; the right diaphragm is elevated; the heart is not retracted.

chial and intramural types of carcinomas, later studies may show considerably more parenchymal involvement and more secondary pneumonic changes. In those cases in which the primary growth is in the main bronchus and is of the intramural variety,

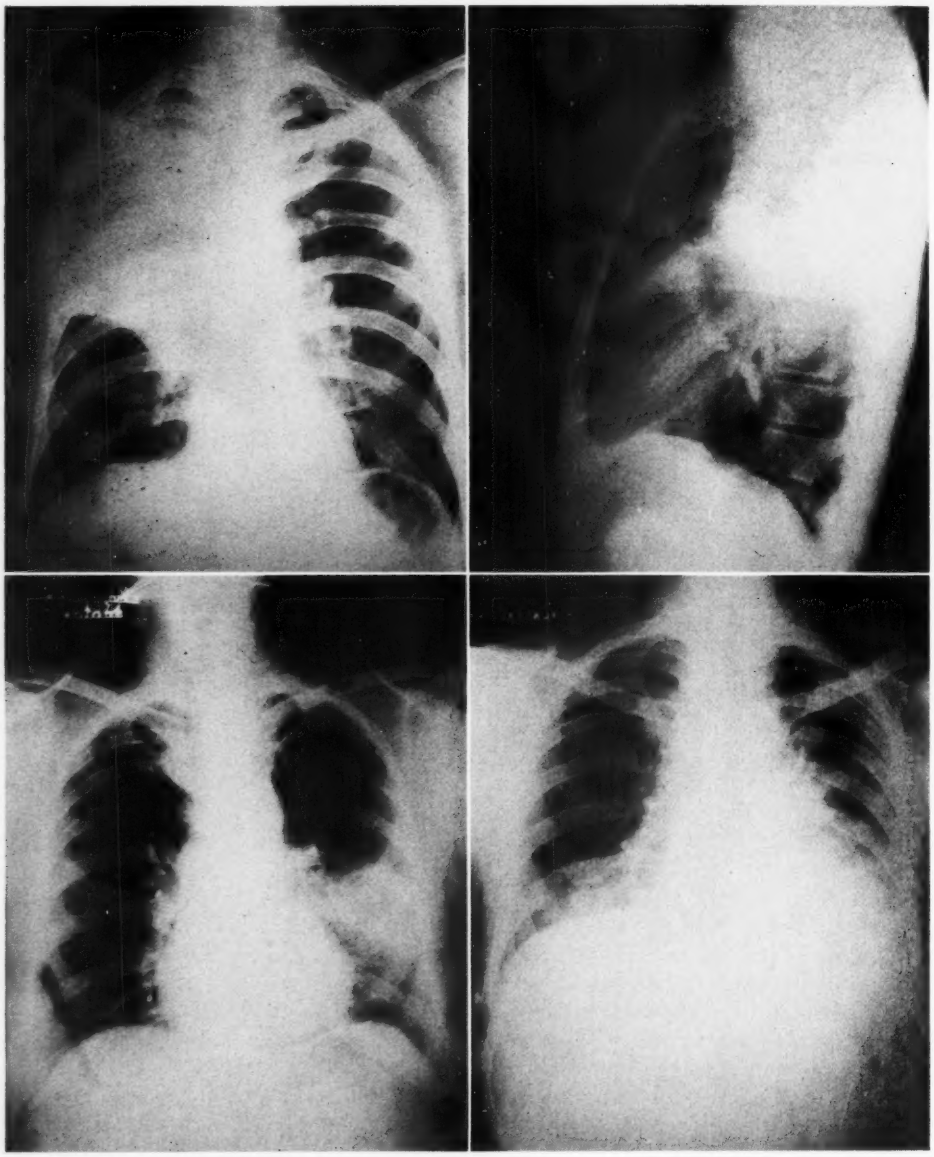


Fig. 5 (*upper left*). Atelectasis of the right upper lobe due to an obstructing carcinoma of the bronchus supplying that lobe. The remainder of the lung tissue appears emphysematous. The heart is not displaced.
Fig. 6 (*upper right*). Same case as shown in Figure 5. Lateral view of the chest in a case of carcinoma of the right upper lobe. Note the sharp horizontal line of demarcation and the opacity above it.
Fig. 7 (*lower left*). A triangular veil-like opacity extending out into the left lung-field.
Fig. 8 (*lower right*). Obstructing carcinoma of the left lower lobe bronchus. The line of demarcation between the diseased and healthy lung tissue is indistinct. In addition, there is a pathologic fracture of the anterolateral part of eighth rib on the right side.

the retrograde lymphatic infiltration of the lung causes a fan-shaped, veil-like carcinomatous and inflammatory opacity. A roentgenogram of this lesion shows considerable striation, or linear infiltration of the lung, which extends outward from the hilum (Fig. 7). Within these striations, there are many various-sized, distinct nodular areas of greater density than the surrounding opacity. These areas correspond to sites of bronchial lymph node enlargement. The radiolucency of the lung appears unevenly diminished, the greatest density being at the hilus. If, however, the primary growth originated in a secondary bronchus, the spread is in a lobar fashion and the roentgenogram shows similar linear infiltration, opacity, and nodular areas sharply confined to one lobe of the lung and limited by the interlobar fissures (Figs. 5 and 6). The area of infiltration is triangular, the apex of which is directed toward the hilum. In those cases in which the primary growth is least malignant, the spread is comparatively slow and the unaffected lung tissue may undergo emphysematous changes; the diaphragm may become depressed and the trachea pushed toward the contralateral side. The contrast of emphysematous lung and infiltrated lung makes the interlobar fissure appear as a sharp line of demarcation, when the carcinoma is in the upper lobe. When, however, it is in the lower lobe the interlobar line of demarcation is less distinct and often irregular (Fig. 8). In the final lobar stage, the lobe becomes dense, irregularly opaque, and contains many areas of increased density (nodular areas), the outline of which is indistinct. The lobar type may be present in any part of the lung, but is more often seen in the upper lobes where it is frequently confused with tuberculosis and pneumococci pneumonia.

Parenchymal.—The parenchymal lesion is generally an extrabronchial neoplastic process, arising from a secondary or tertiary branch bronchus, which grows more or less centrifugally about the bronchus as an axis (Fig. 9). On the roentgenogram it appears, therefore, as a circumscribed round or ovoid opacity distinct from the hilum and periphery of the lung. The lung tissue about the primary growth often undergoes emphysematous changes. As the growth increases in size, it generally loses its delineation and appears as an agglomeration of soft and hard shadows (Fig. 10). Extending outward from the edges of the tumor and into the surrounding lung tissue there are infiltrative neoplastic and inflammatory projections. At this stage, the line of demarcation between tumor and lung tissue becomes indistinct. The infiltrative strands leading toward the hilum are denser than those leading toward the periphery. The hilar glands become enlarged and dense. As the process continues, the infiltration becomes more pronounced, the original growth becomes further obscured, and the entire lobe becomes unevenly opaque. At this stage, it cannot be distinguished from the lobar type of neoplasm which had its inception at the hilum. Still later, the entire lung may become involved in the neoplastic process, at which time it cannot be distinguished from the advanced hilar form.

Peripheral.—This form of primary carcinoma of the lung appears to have been given little attention, as evidenced by the paucity of references to it in the literature. Most writers believe it to be pleural involvement, secondary to the hilar or parenchymal forms. The peripheral form of primary carcinoma takes origin in the smaller bronchioles, perhaps the terminal bronchioles near the surface of the lung, and rapidly infiltrates and extends along the subpleural lymphatics, chest wall, and diaphragm. In the early stages, roentgen examination shows a localized opacity at the pleura with proximal lung infiltration. It is very frequently accompanied by an encapsulated hydrothorax (Fig. 11). As the process advances, it involves the entire pleura and the peripheral part of the lung-field. On the roentgenogram there is an uneven opacity of the hemithorax which in many ways resembles a pleural

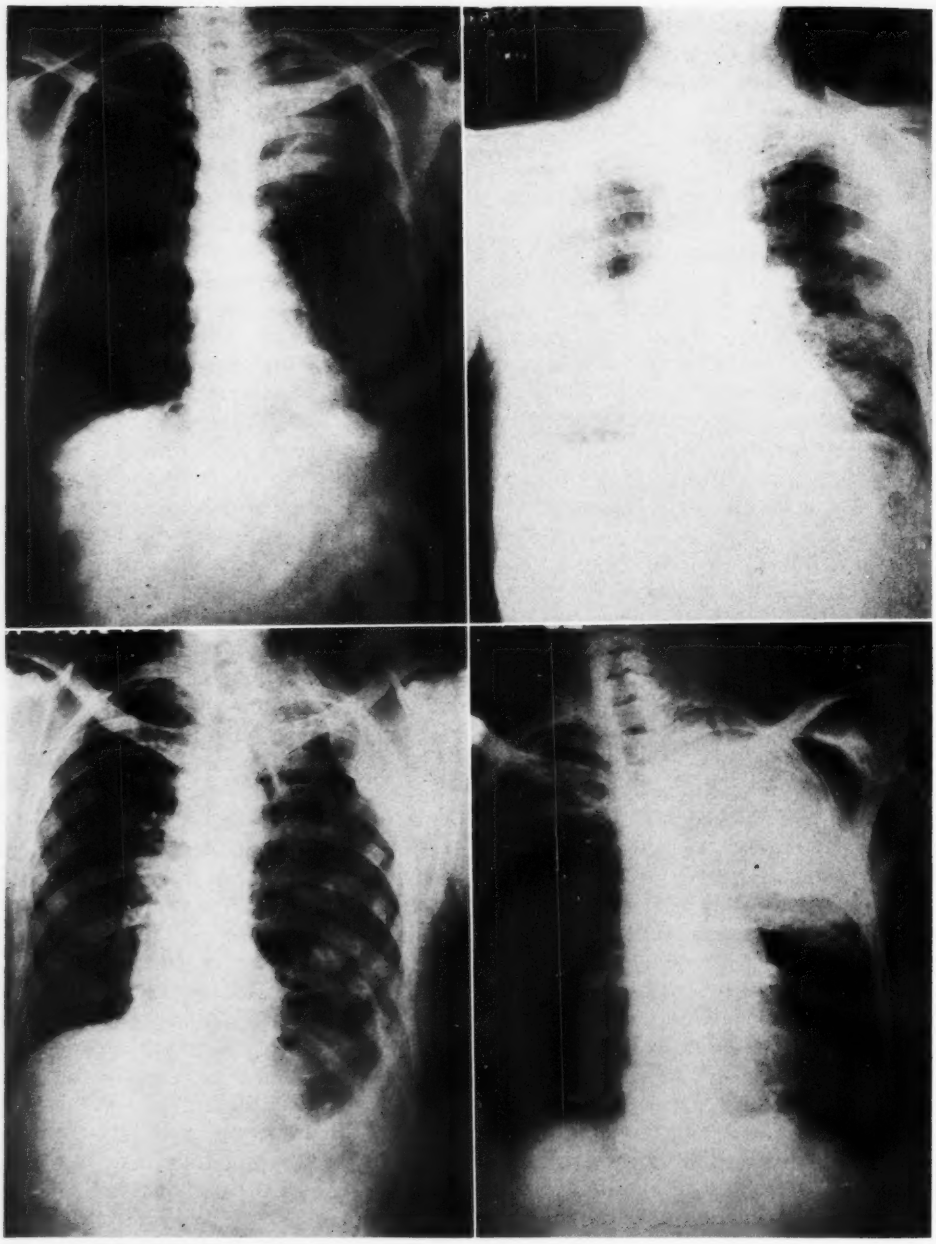


Fig. 9 (*upper left*). A parenchymal (central) carcinoma of the left upper lobe bronchus. The area medial to the growth is infiltrated, whereas the lateral part is clear. The lower part of the ovoid shadow presents an annular shadow (excavation).

Fig. 10 (*upper right*). A large parenchymal carcinoma of the right lung with infiltration about the mother growth.

Fig. 11 (*lower left*). Carcinoma of the left upper lobe at the periphery of the lung-field. There is a pathologic fracture of the posterolateral part of the fourth rib on the left side. The tumor and pleura are well demarcated from the underlying lung tissue.

Fig. 12 (*lower right*). Peripheral (subpleural) carcinoma of the left upper lobe. There is an ovoid opacity extending from the third rib down to below the level of the seventh rib. The surrounding pleura is infiltrated. There is a pathologic fracture of the fourth rib which overlies the tumor.

effusion. Not infrequently it will erode the underlying ribs (Fig. 12). The position of the mediastinum remains unaltered. Attempts at aspiration may yield a small amount of fluid. Roentgen studies after the aspiration show no change in the opacity of the hemithorax as compared with the roentgen studies made before the aspiration. This is because the underlying opacity is due to a carcinomatous lymphangitic infiltration. Careful examination of the roentgenogram may show miliary dense deposits on the surface of the pleura and in the peripheral lung-fields. The hilar glands remain uninvolved until late in the course of the disease. As the pleural nodules grow they tend to coalesce and produce a uniform opacity.

Regarding apical peripheral carcinomas, Jacox quotes Pancoast as follows: "The name of 'superior pulmonary sulcus tumor' has been given it because this term implies its approximate location and a lack of origin from lung, pleura, ribs, or mediastinum. It is possible that this new designation may be changed again, with a better knowledge of the histopathology of the growth." He further adds, "Opportunity to examine autopsy material from a case of this sort has convinced me that, at least in this instance, the tumor arose from the mucosa of the terminal bronchioles in the apex of the lung, and that the name 'primary carcinoma of the pulmonary apex' might be appropriate." Many investigators are in accord with Jacox and believe that the so-called "superior pulmonary sulcus tumors" are carcinomas of the lung, of peripheral apical origin (Fig. 13).

The foregoing, in summary form, describes the three roentgen forms of primary carcinoma of the lung, as seen in the uncomplicated cases, and the pathogenesis of each. The roentgenographic intrathoracic complications and secondary changes which may ensue are: (*A*) Pleural effusion; (*B*) bronchiectasis; (*C*) excavation of the neoplasm, and (*D*) metastases (intrathoracic).

(*A*) *Pleural Effusion.*—The presence of a hydrothorax is so frequently encountered in carcinoma of the lung that in a patient of cancer age and, in the absence of a previous cardiac, nephritic, or pneumonic process, it should always be looked upon with a suspicion of being the result of an underlying malignancy, until proven otherwise. There is nothing unusual in the roentgenographic appearance of an effusion due to a malignancy of the lung, except, perhaps, that the position of the mediastinum is generally unaffected by the fluid (Fig. 14). The mediastinum usually remains in a relatively normal position and is not displaced as it is in the case of a pleural effusion following an acute inflammatory process. Butler and Ritvo believe that the upper limit of the fluid generally describes a curvilinear line extending upward toward the axillary region. This phenomenon is more often encountered in effusions secondary to the parenchymal neoplasm than in the other forms. The density of the shadow cast by the fluid will vary with the thickness of the layer of fluid present. Various degrees of obliteration of cardiac, pulmonary, and diaphragmatic detail may also be observed. Not infrequently, in the early hilar and parenchymal types of neoplasm, the fluid present is of such small quantity that it is entirely confined to the costophrenic angle. As the disease progresses, the lateral hemithoracic and apical regions remain relatively clear, whereas, the central and hilar areas become more opaque. This may be due to the fact that the lateral and apical parts of the thorax are least involved in the reactionary pleuritis. The adhesions resulting from the pleuritis further tend to limit the extent of the effusion. It has been pointed out by Kirklin, that fluid in the pleural cavity is more commonly encountered in those cases in which the carcinoma originates in the lower lobes than in the upper lobes.

In the hilar cases, pleural effusion is usually a late manifestation of the disease and may be accompanied by some contraction of the hemithorax. In those cases in which there is bronchial obstruction

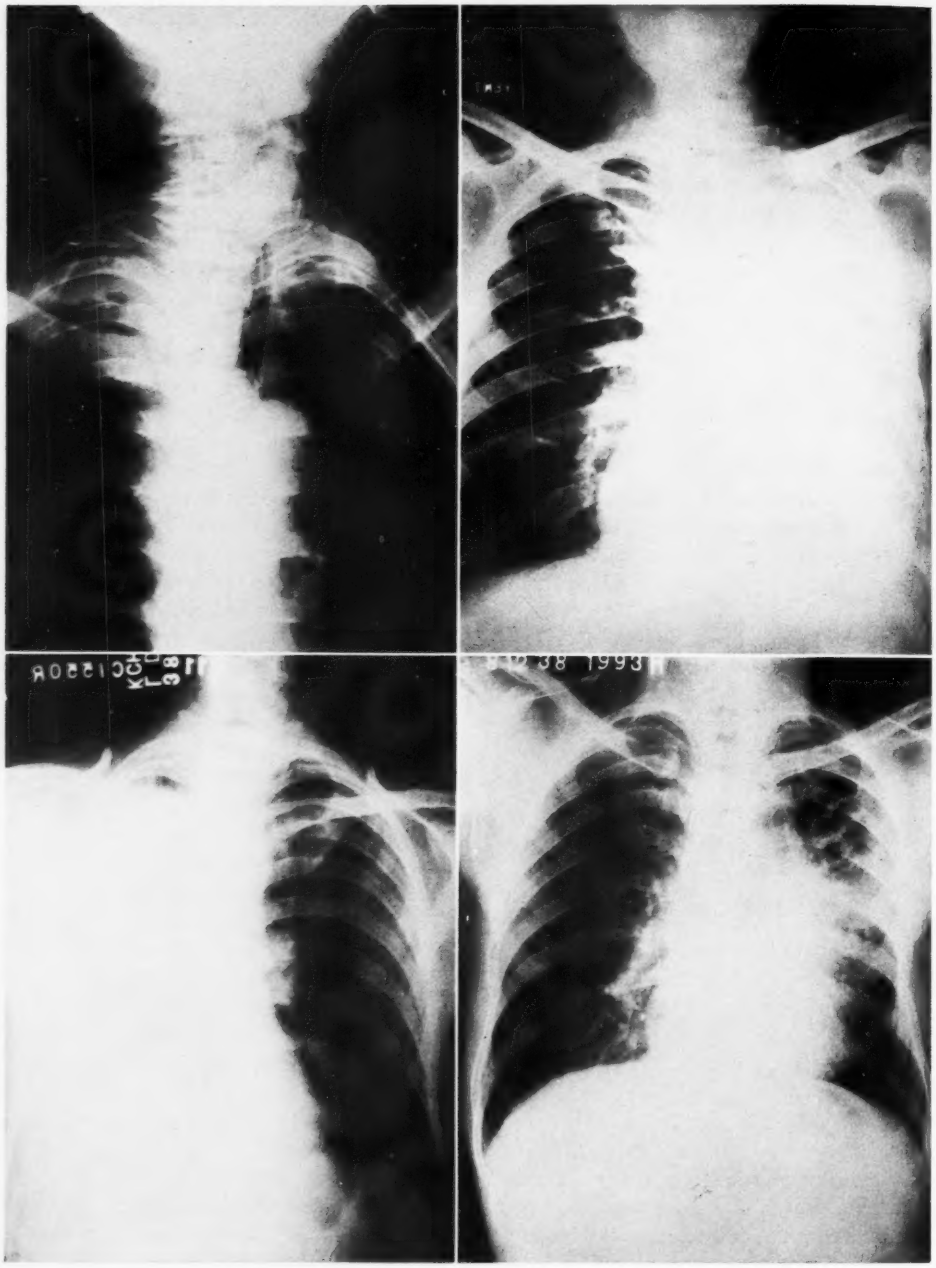


Fig. 13 (*upper left*). A peripheral tumor (superior pulmonary sulcus tumor) arising from the apex of the right lung. The trachea is displaced to the contralateral side. In addition, there is demonstrable a local erosion of the first rib and a periosteal reaction along the inferior border of the second rib. (Bucky exposure.)

Fig. 14 (*upper right*). Carcinoma of the left lung with massive pleural effusion. The heart is slightly displaced to the right. The contour of the left hemithorax is unaltered.

Fig. 15 (*lower left*). Right hydrothorax and atelectasis of the right lung. The heart is slightly retracted to the right.

Fig. 16 (*lower right*). Carcinoma of the left upper lobe which presents several areas of cavitation.

and atelectasis associated with the pleural effusion, the fluid may partially counteract the increased negative tension due to the atelectasis, and, therefore, leave the mediastinum and intercostal spaces relatively unaltered (Fig. 15). If the fluid does not completely occupy the hemithorax, as is frequently the case, the underlying pneumonic, infiltrated lung may be visible above or through the fluid. This can be particularly well brought out by a Potter-Bucky exposure. At the same time, one may also note enlarged hilar lymph nodes and the tumor itself. In the parenchymal cases, fluid generally develops earlier than in the hilar cases. The tumor and its surrounding reactionary pneumonitis again may be seen in part, or *in toto*, depending upon the density of the fluid. Pleural effusion accompanying a parenchymal neoplasm, is generally more massive, and not encapsulated, than it is in the cases of effusion following the hilar neoplasm. The peripheral carcinomas are always accompanied by a variable amount of reactionary pleural effusion. This effusion usually takes place early in the course of the disease and is localized to the region of the tumor. In the later stages the fluid may obscure the neoplasm so that it is difficult to distinguish between tumor infiltration and effusion. In the peripheral neoplasia, which are accompanied by an early massive effusion, the mediastinum tends to be displaced to the contralateral side. As the disease progresses, the entire pleural surface becomes involved in a carcinomatous lymphangitis. This infiltration may be distinguished from pleural effusion in that the roentgenogram made after the aspiration fails to show any appreciable change in the opacity from that made before the aspiration was performed.

(*B*) *Bronchiectasis.*—Not infrequently bronchiectasis is encountered in malignancy of the lung. It is more commonly associated with hilar intrabronchial carcinomas involving the lower lobe bronchi. As a result of bronchial occlusion, increased bronchial secretion, stagnation, and interference with bronchial drainage, secondary suppuration takes place distal to the obstruction. This process is progressive, and ultimately results in bronchiectatic changes (Figs. 16 and 20). Vinson, Moersch, and Kirklin are of the opinion that bronchostenosis further interferes with venous and lymphatic drainage of the bronchi, resulting in a collection of the secretions in the dependent parts of the bronchi. As the bronchioles become distended, the bridge of thinned-out tissue interposed between the dilated bronchioles becomes reduced, permitting the approximation of the bronchiectatic cavities. Eventually, due to infection or pressure necrosis or interference with the blood supply, these bronchioles rupture into one another, forming pockets simulating small abscess cavities.

(*C*) *Excavation of the Neoplasm.*—Roentgenographic studies do not reveal excavation of bronchogenic carcinomas as frequently as it is encountered at necropsy. From postmortem studies one notes that cavitation is quite common, and that the cavities vary in size from about a centimeter in diameter to complete excavation of a lobe of the lung. Cavitation of a bronchogenic carcinoma is more commonly encountered in the parenchymal, extrabronchial, rapidly expanding type of tumor than in the other forms, although it also occurs in the other pulmonary neoplasia.

Cavitation in carcinoma of the bronchus is the result of an aseptic central necrosis, sloughing, and extrusion of the sequestrum. This, therefore, requires a patent bronchus. The prime cause of the necrobiosis is interference with the blood supply by the rapid growth of the neoplasm. Once cavitation has occurred it may be enhanced by secondary suppuration, which frequently takes place. Infection following necrosis of the tumor may alter the clinical course of the disease but it rarely changes the roentgenographic picture so that it does not present some of the characteristics common to an excavated malignancy of the lung.

The roentgenographic appearance of a carcinoma of the lung which has undergone excavation is characteristic. The vomica is thick-walled and irregularly

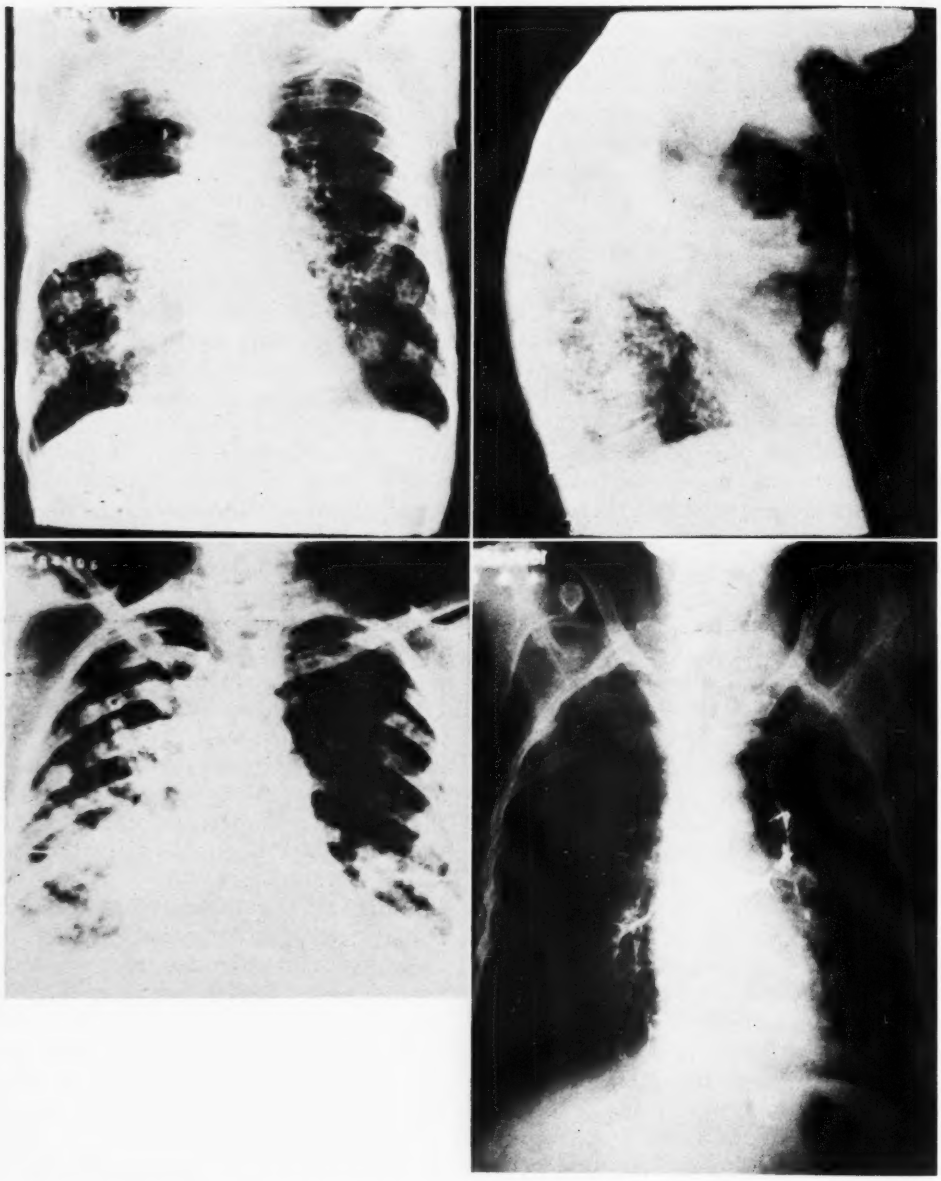


Fig. 17 (*upper left*). Excavated carcinoma of the right upper lobe. There is considerable infiltration about the neoplasm. The cavity contains several thickened polypoid processes.

Fig. 18 (*upper right*). Same case as shown in Figure 17, lateral view. In addition to the findings noted in Figure 17, there is a fluid level present within the cavity.

Fig. 19 (*lower left*). Carcinomatous pneumonitis of both lungs, more pronounced on the right side.

Fig. 20 (*lower right*). Obstruction of the left main bronchus which is complete in the lower lobe. There is a crescentic dense shadow at the left hilus and bronchiectatic areas at the left base. There is an abrupt cessation to the flow of the contrast medium at the beginning of the left lower lobe bronchus.

infiltrated (Figs. 17 and 18). Extending outward from the cavity and into the surrounding lung tissue, there are strands of carcinomatous and inflammatory projections, while extending into the cavity proper there are irregular short processes which appear like foreshortened stalactites and stalagmites. Within the cavity there may be one or more fluid levels. The bronchus leading to the cavity is usually densely infiltrated and appears to end in a unilateral group of enlarged hilar or mediastinal glands.

(*D*) *Metastases* (*Intrathoracic*).—Regardless of the duration, size, or position of the primary growth, metastasis may occur at any time during the course of the disease. Roentgenologically, we can distinguish three sites of metastatic deposits: (1) In the lungs and pleura; (2) in the bony framework, and (3) in the heart and pericardium.

(1) Metastatic deposits in the lung appear as discrete opaque nodules in the region of the mother growth or may be widespread throughout the same lung and/or contralateral lung. When generalized, it has the appearance of a miliary pulmonary carcinosis. On the roentgenogram there are numerous, various-sized, round, discrete, opaque shadows scattered throughout the lung-fields. Frequently these deposits appear like a diffuse irregular infiltration of the lung. Lorey describes a case of miliary carcinosis, due to erosion of a pulmonary vessel, with subsequent hematogeneous spread of the disease throughout both lungs. Metastasis to the pleura is almost always associated with pleural effusion. When the fluid is removed one may observe round dense areas of opacity, irregularly distributed on the surface of the pleura. (2) Secondary deposits in the ribs, clavicles, sternum, and vertebræ are frequently encountered. These structures show areas of rarefaction and at times pathologic fractures. (3) Metastasis to the heart (pericardium) is evidenced by a collection of fluid in the pericardial sac, which is indicated on the roentgenogram by an obliteration of the normal cardiac configuration.

Schwartz and Auerbach have pointed out that there are instances of bronchogenic malignancies in which a "carcinomatous pneumonia" takes place (Fig. 19). They show cases in which the bronchus apparently presented no evidence of carcinoma but in which there were many solid foci filling the alveolar spaces and perivascular lymphatics. Microscopic examination of representative tissue showed a squamous-cell carcinoma.

The above classification is simply a means of identification of the site of origin and mode of spread of a primary cancer of the lung. It must not be construed that these forms remain distinct, for they do not. The parenchymal tumor may involve by extension the hilum and pleura, simulating a malignant growth which has arisen from either of these latter sites and which has progressed. Likewise, may the other forms extend and simulate one another.

As a further aid in the diagnosis, we may resort to the accessory roentgenological methods, such as bronchography and pneumothorax. The judicious instillation of lipiodol into the bronchial tree is frequently of inestimable value in the diagnosis of bronchogenic malignancy. Bronchographic studies readily portray alterations in the caliber of the bronchial lumen as well as the site of the bronchial obstruction (Figs. 20 and 21). On the roentgenogram an intrabronchial growth causing complete obstruction is denoted by an abrupt cessation of the flow of the contrast medium. At the point of the obstruction the radiopaque material is usually collected in a dilated bronchial pocket, the distal part of which is irregular and niched. At times, and in those cases in which there is an incomplete bronchostenosis, the contrast substance may enter the bronchus and assume a "rat-tail"-like narrowing. In other instances, and in those cases in which there is an infiltration in the wall of the bronchus, the bronchial wall is outlined unevenly and at the site of

the neoplasm there is a filling defect or a niche. Pruvost and Quenu, having encountered difficulty in introducing contrast material into pulmonary cavities *via* the bronchus, advised its direct introduction through the chest wall, transpleurally. This procedure can be used to outline cancerous cavities, but is not without some degree of danger. Recently, Coryllos and Ornstein have used this method to outline tuberculous cavities, in which cases the bronchus leading to the cavity was obstructed. Artificial pneumothorax is another roentgenologic diagnostic aid. By partially collapsing the lung one may be able to differentiate between an intrapulmonary and an extrapulmonary tumor. By replacing a pleural effusion with air or gas, a neoplasm previously obscured by the fluid may become visible. In the case of a peripheral neoplasm, which cannot be differentiated from a localized collection of fluid, or in the case of a carcinomatous lymphangitis of the pleura, the separation of the pleuræ and the contrast effect of the pneumothorax will aid in the localization of the pathologic process (Fig. 22).

In the foregoing statements an attempt has been made to correlate the intrathoracic pathologic changes associated with a carcinoma of the lung and the ensuing roentgenographic findings. It is important to recognize the fact that the shadow seen on the roentgenogram is not entirely due to the neoplasm but is partly contributed to by the surrounding lymphangitis and pneumonitis. The diagnosis of carcinoma of the lung (from roentgenographic studies) is dependent upon the recognition of these changes. In the later stages the various forms of carcinoma of the lung will so closely simulate each other that a differentiation between them will not be possible. Nor does it matter whether or not one is able to make this differentiation at this late stage. What does matter is the early recognition of the

Fig. 21.

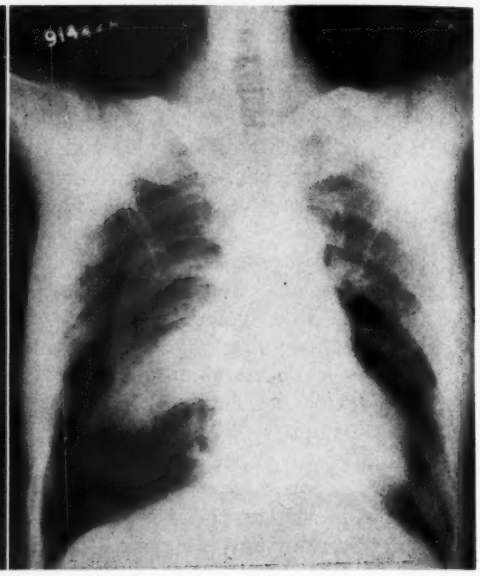


Fig. 22.

Fig. 21. Same case as shown in Figure 20, lateral view of the thorax. There is a pooling of the radiopaque substance in the dilated left main bronchus.

Fig. 22. Induced pneumothorax revealing a carcinoma of the lung previously not manifest because of the surrounding normal lung tissue.

disease. If carcinoma of the lung is to be diagnosed at a time when it will still be amenable to some therapeutic measure, it must be recognized earlier. To this end, one should not be satisfied with a simple anteroposterior or a postero-anterior roentgenographic examination of the thorax. Roentgenograms should be taken in every direction possible. Often lateral, oblique, and Bucky exposures will be necessary to give the desired information as to the presence of a neoplasm, its size and location, and whether or not it has spread. In addition, such roentgenograms should be taken during inspiration and during expiration. An obstructive emphysema with mediastinal displacement during respiration is pathognomonic of bronchial obstruction, even though the surrounding lung tissue is apparently "normal." In some clinics stereoscopic and tomographic studies have been employed in an attempt at an earlier recognition of pulmonary carcinomas. It is beyond the scope of this communication to discuss these latter procedures.

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REFERENCES

(1) ASSMANN, H.: Zur Frage der Pathogenese und zur klinik des Bronchialkarzinoms. Med. Klinik, **20,** 1796–1799, January, 1924.

(2) BUTLER, P. F., and RITVO, M.: Primary Carcinoma of the Lung: Diagnosis and Treatment by X-ray. New England Jour. Med., **207,** 435–443, Sept. 8, 1932.

(3) CARMAN, R. D.: Primary Cancer of the Lung. Med. Clin. North America, **5,** 307–354, 1921.

(4) CLARKE, B. E.: Superior Pulmonary Sulcus Tumor (Pancoast). Am. Jour. Path., **10,** 693, 1934.

(5) CORYLLOS, P. N., and ORNSTEIN, G. G.: Giant Tuberculous Cavities of the Lung. Jour. Thoracic Surg., **8,** 10–54, 1938.

(6) FARIÑAS, P. L.: Serial Bronchography in Early Diagnosis of Bronchial Carcinoma. Am. Jour. Roentgenol. and Rad. Ther., **32,** 757–762, December, 1934.

(7) GRAEF, I., and STEINBERG, I.: Superior Pulmonary Sulcus Tumor. Am. Jour. Roentgenol. and Rad. Ther., **36,** 293–300, September, 1936.

(8) HIRSCH, I. SETH: The Roentgen Diagnosis of Malignant Neoplasms of the Lung. RADIOLOGY, **9,** 470–496, December, 1927.

(9) HOCHBERG, LEW A., and LEDERER, M.: The Early Manifestations of Primary Carcinoma of the Lung. Arch. Int. Med., **63,** 80–99, January, 1939.

(10) HYDE, T. L., and HOLMES, G. W.: The Roentgenological Aspects of Primary Tumors of the Lung. Am. Jour. Roentgenol. and Rad. Ther., **18,** 235–243, 1927.

(11) JACOX, H. W.: Superior Pulmonary Sulcus Tumor. Jour. Am. Med. Assn., **103,** 84–87, July 14, 1934.

(12) KIRKLIN, B. R.: Roentgenological Signs and Differential Diagnosis of the Principal Malignant Diseases of the Lungs and Mediastinum. Wisconsin Med. Jour., **31,** 95–99, February, 1932.

(13) LOREY, A.: Die Akute Miliartuberkulose im Röntgenbild. Ergebn. d. med. Strahlenforsch., **1,** 131–144, 1925.

(14) OTTEN, M.: Die Röntgendiagnose der Lungengeschwulste. Fortschr. a. d. Geb. d. Röntgenstrahlen, **15,** 1–31, 1910.

(15) PANCOAST, H. K.: Superior Pulmonary Sulcus Tumor. Jour. Am. Med. Assn., **99,** 1391–1396, Oct. 22, 1932.

(16) PRUVOST, P., and QUENU, J.: L'exploration des grands abcès pulmonaires par l'injection transpariétale de lipiodol. Presse med., **45,** 1397–1400, Oct. 2, 1937.

(17) RABIN, C. B., and NEUHOF, H.: A Topographic Classification of Primary Cancer of the Lung. Its Application to the Operative Indications and Treatment. Jour. Thoracic Surg., **4,** 147–164, December, 1934.

(18) REISNER, D.: Carcinomatous Cavities of the Lung. Quart. Bull. Sea View Hosp., **1,** 322–336, April, 1936.

(19) SCHWARTZ, S., and AUERBACH, O.: Non-tuberculous Pulmonary Disease Simulating Pulmonary Tuberculosis. Quart. Bull. Sea View Hosp., **4,** 95–118, 1938.

(20) STIVELMAN, B. P.: The Roentgen Ray in the Diagnosis of Primary Pulmonary Neoplasm. Jour. Am. Med. Assn., **91,** 1690–1694, Dec. 1, 1928.

(21) TOVELL, H. M.: X-ray Findings in Primary Carcinoma of the Lung. Canad. Med. Assn. Jour., **15,** 485–489, 1925.

(22) TUTTLE, W. M., and WOMACK, N. A.: Bronchogenic Carcinoma: A Classification in Relation to Treatment and Prognosis. Jour. Thoracic Surg., **4,** 125–146, December, 1934.

(23) VINSON, P. P., MOERSCH, H. J., and KIRKLIN, B. R.: Value of Bronchoscopy in Diagnosis of Malignant Conditions of the Lungs. Jour. Am. Med. Assn., **91,** 1439–1443, Nov. 10, 1928.

(24) WASCH, M. G., and EPSTEIN, B. S.: Bronchogenic Carcinoma: Analysis of 54 Cases with Roentgenological Classification. Am. Jour. Med. Sci., **190,** 362–371, September, 1935.

A ROENTGENOLOGIC CONSIDERATION OF GASTRITIS[1]

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RECENTLY there has been a noticeable increase of interest in the roentgenologic diagnosis of gastritis. From the present knowledge educed from the gastroscopic and radiologic studies, the roentgenologist has been greatly aided in recognizing the anatomic appearance of the normal and abnormal picture of the gastric mucosa. Although the gastroscopic method of examination stands pre-eminently as the procedure of choice in the diagnosis of gastritis, it is a complementary procedure that is difficult to utilize as a routine measure. This communication is primarily concerned with the radiologic report of the different forms of gastritis, with a presentation of five cases which roentgenologically simulate carcinoma of the stomach.

Gastritis has long been recognized from autopsy and surgical specimens. The histologic studies of surgical specimens stimulated interest in this pathologic entity. However, not until the gastroscope became fully developed, was the true nature of the different forms of gastritis recognized in the living subject.

In the more recent literature, the following authors have contributed to this subject, namely, Darling; Prévôt; Larimore; Simpson; Ansprenger and Kirklin; Schindler and others; Holmes and Schatzki; Benedict; Monaghan, Bockus, and others; Stix, and others.

The frequency of gastritis has not as yet been fully established. There can be no question that certain forms of gastritis, such as the superficial variety, occur with great frequency. Most of these, however, heal spontaneously. On the other hand, comparatively few cases become chronic. The superficial forms of gastritis may be disclosed only by gastroscopic studies, while the more chronic forms may be recognized by both the gastroscope and roentgen methods of examination.

Heretofore, there have been few statistical studies to determine the incidence of gastritis. Recently, the frequency of gastritis has been determined by means of routine gastroscopic examinations. Schindler and his co-workers have examined 2,500 cases gastroscopically, found that 23 per cent were normal and approximately 50 per cent presented mucosal changes representing a chronic inflammatory process. The percentage of cases of gastritis seems to be rather high in his series. It is more probable that in the routine examinations the percentage of gastritis cases will prove to be much lower than reported.

The etiology of gastritis varies considerably. It may be due to the following causes: mechanical; chemical; infectious; bacterial; allergic; post-operative, etc. According to Darling and other authors, alcohol is an exceedingly important factor, giving rise to a classical form of chronic gastritis. Lead poisoning and other corrosive substances also produce gastritis.

Age and Sex Incidence.—Gastritis is most frequently observed in adults between the third and sixth decades. Its incidence increases with advancing years. It is of interest to note that males predominate in cases of hypertrophic gastritis. On the other hand, in the superficial mucosal variety the sex incidence is more evenly distributed.

Classification.—Numerous classifications have been formulated for the study of this condition. A simple classification based upon gross anatomical changes is more desirable for diagnostic purposes.

[1] Presented before the Twenty-fourth Annual Meeting of the Radiological Society of North America, at Pittsburgh, Nov. 28–Dec. 2, 1938.

The following classification may be used in the study of gastritis:

- (1) Simple
  - Superficial
  - Erosive
  - Hemorrhagic
  - Follicular
  - Membraneous
- (2) Hypertrophic
  - Superficial
  - Localized (involving all coats)
  - Diffuse (linitis plastica type)
- (3) Ulcerative
  - Ulcerative
    - Simple, in peptic ulceration
    - Hypertrophic
  - Corrosive
    - Superficial
    - Hypertrophic
- (4) Atrophic
- (5) Phlegmonous

In recent years great strides have been made in understanding the variable pathologic states of the different forms of gastritis. The pathologic picture depends in a great measure upon the variety of inflammatory changes encountered, and the depth of the diseased process.

In the superficial mucosal form, the mucosa is reddened and slightly swollen; there may or may not be superficial erosions. It may be localized or diffuse. The erosions may at times be recognized as small flecks of opaque medium, which are temporarily held by the ulcerated surface. The superficial forms ordinarily cannot be recognized by roentgen studies.

Hypertrophic gastritis produces a characteristic picture. The mucous membrane is swollen and thickened. The rugæ are thickened, elevated, broadened, rigid, and show alteration of form and shape, becoming tortuous and irregular. The hyperplasia of the mucosa produces a granular appearance, which is pathognomonic of hypertrophic gastritis. In the more advanced cases, the picture resembles one of a polyposis. Multiple erosions are not uncommon. Reynberg points out that the increase in the caliber of the folds is of significance only when the furrows between them are widened, accompanied by a reduction in the number of folds. The rigidity of the folds is persistent on repeated examination and cannot be erased by manipulation or pressure. It is also noteworthy to point out that the serrations along the greater curvature, which are often seen in the normal case, are markedly exaggerated in cases of hypertrophic gastritis. The condition may be localized or diffuse. The localized variety often resembles a gastric neoplasm.

Simple ulcerative gastritis is commonly seen in gastric ulceration. It is usually localized in the area surrounding the ulcer. It is recognized roentgenologically as a localized indurated area produced by thickening and swelling of the tissues.

Ulcerative hypertrophic gastritis is an extremely rare form of this affection. It resembles carcinoma, from which it is difficult to differentiate. It is often possible to demonstrate a benign ulcer niche defect on the lesser curvature. The wall of the stomach is greatly thickened, producing a neoplastic type of defect. The inflammatory mass can be felt to roll under the palpating hand in the fluoroscopic examination. The mucosal folds are markedly thickened, reduced in number but

are not entirely obliterated. Two examples of this variety of gastritis are presented.

Atrophic gastritis is portrayed by a flattening of the folds, giving the picture of a smooth mucosal surface, devoid of mucosal markings. The mucous membrane and the entire gastric wall is atrophic and thinned out.

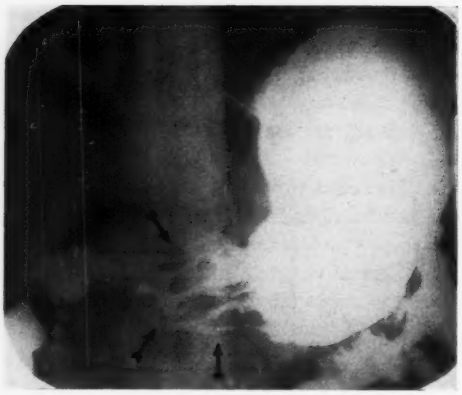

Fig. 1. A case of simple hypertrophic gastritis.

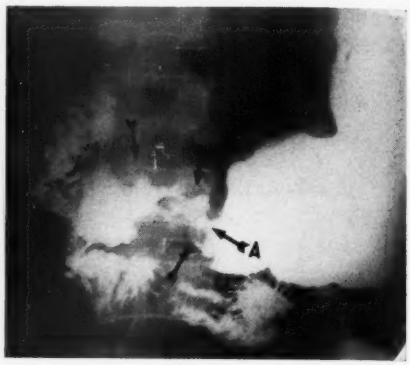

Fig. 2. An ulcerative hypertrophic gastritis is shown. Note the niche defect at arrow *A*, and the marked deformity which simulates a carcinoma.

Phlegmonous gastritis chiefly involves the submucosa, which becomes markedly thickened and when cut shows a purulent material exuding from it. The condition is comparatively rare. It may be localized or diffuse. Roentgenologically it is recognized by a diminution in the size of the stomach. It tends to encircle the whole circumference of the gastric wall, producing the picture of linitis plastica. The mucosal folds show evidence of hypertrophy and in advanced cases may be partially or completely obliterated.

In corrosive gastritis, all degrees of inflammation may be observed, ranging from superficial hemorrhagic necrotic areas to a marked shrinking of the whole stomach due to contraction and thickening. The lesser curvature usually reveals a more extensive process than the greater curvature, especially in the pyloric portion. In this condition the roentgen examination shows a rigid, markedly swollen mucosa, which reduces the size of the gastric lumen to the form of a funnel toward the pylorus. Scar retraction often leads to stenosis and pipe-like deformities of the pylorus. The stomach is often markedly reduced in size. In more severe cases, the condition may be complicated by perforation and phlegmon. Giuntoli reports a case in a youth who swallowed a dilute solution of sulphuric acid, in which he found a stenosis of the pylorus and an ulcerous enteritis with stenosis.

Post-operative gastritis is a common complication following gastro-enterostomy. According to Reynberg, gastro-enterostomy is regularly followed by a chronic gastritis, which appears soon after the operation.

Allergic gastritis is probably more common than a survey of the literature would indicate. In this condition there are superficial changes in the mucosa in the form of redness and swelling. Its recognition by means of the roentgen ray is most difficult to disclose; however, the condition has been roentgenologically recognized by Hansen and Simonsen, who describe two cases. They noted that after a usual barium meal the gastric rugæ appeared normal, but on re-examination after an egg-yolk or milk containing barium, the gastric rugæ were widened, which, according to these authors, indicated a "hyperergic" gastritis.

They also found a co-existing pylorospasm in both cases.

The diagnosis of gastritis by means of the roentgen ray frequently presents many difficulties. The varying degree of involvement and the different forms of gastritis produce different roentgenologic pictures, which often require much consideration and a thorough knowledge of the pathologic process, together with all clinical data, in order to make a correct diagnosis. Our interest has been chiefly centered in the hypertrophic mucosal and atrophic forms. Increasing experience in the portrayal of roentgenologic findings in other forms of gastritis has aided us in more accurately diagnosing these conditions.

Attention, however, must be directed to the fact that the diagnosis of gastritis may be eluded by this means of examination. The principal disadvantage of the x-ray is its failure to disclose evidence of gastritis in all cases. It must also be pointed out that a normal mucosal relief may be demonstrated in certain cases of gastritis.

Fig. 3.

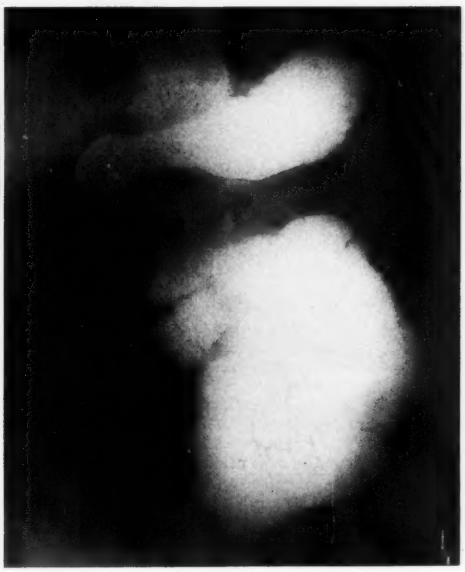

Fig. 4.

Fig. 3. An extensive ulcerating gastritis is demonstrated. Note the ulcer defect on lesser curvature at arrow *A*. The rugæ are not entirely obliterated, but can be seen in the prepylorus.
Fig. 4. The linitis plastica type of stomach, in a case of gastritis.

Normally, the gastric rugæ run parallel along the lesser curvature. On the greater curvature they are arranged obliquely. In the fundus there are numerous circular rugæ, but in the pyloric portion they usually run parallel to both curvatures and no circular rugæ are present. The elastic autoplastic behavior of the gastric mucosal folds can be demonstrated by means of the roentgen ray. Their course, size, thickness, height, and space between the folds may be clearly demonstrated in the normal stomach.

In gastritis, however, distinct changes in the normal picture of the mucosal folds are readily disclosed. The radiologist must acquire experience in recognizing and interpreting these changes in order to diagnose cases of gastritis.

Five interesting cases are presented to

illustrate the varying roentgen views observed in different forms of gastritis. Case 1 (Fig. 1) illustrates localized hyper-

Fig. 5. A case of corrosive gastritis, simulating carcinoma. Note the ulcer niche defects at arrows *A*. The entire stomach is markedly reduced in size, the reduction being most marked in the pyloric half.

trophic changes of the gastric mucosa, localized in the prepylorus. The folds were rigid, could not be erased by pressure, and the spaces between them were broadened. In Case 2 (Fig. 2) a large irregular annular filling defect is shown at the prepylorus. A small ulcer niche can also be seen on the posterior wall. The entire wall is markedly thickened in the involved area. The defect simulates a carcinoma. At operation the case proved to be an ulcerating gastritis. An extensive irregular filling defect is shown in Case 3 (Fig. 3) involving the pyloric half of the stomach. Also, a large ulceration is seen on the lesser curvature. The large defect resembled a carcinoma. At operation a large, ulcerating, indurated, thickened gastric wall was found. Case 4 (Fig. 4) illustrates a case of alcoholic gastritis, producing a diffuse contraction of the stomach simulating a linitis plastica. The entire stomach is involved. Note the smooth contour of the gastric curvatures and the rapid emptying in the immediate film. Case 5 (Fig. 5) demonstrates a case of corrosive gastritis, after swallowing formaldehyde. Note the small contracted stomach and the pipe-like deformity of the pylorus. Also notice the two ulcerated areas on the lesser curvature (at arrows). At operation a markedly thickened gastric wall was found, involving the entire stomach. The changes were especially marked in the pyloric portion.

SUMMARY

The roentgenologic criteria of the different forms of gastritis are presented. The difficulties encountered in recognizing the condition are emphasized. Five illustrations are shown, demonstrating interesting cases of different forms of gastritis. The diagnosis of certain forms of gastritis cannot be made without considering all clinical data.

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REFERENCES

(1) ANSPRENGER, A., and KIRKLIN, B. R.: Roentgenologic Aspects of Chronic Gastritis: Critical Analysis. Am. Jour. Roentgenol. and Rad. Ther., **38,** 533–541, October, 1937.

(2) BENEDICT, E. B.: Chronic Gastritis: Clinical Discussion Based on Gastroscopic Examination. New England Jour. Med., **212,** 468–472, March 14, 1935.

(3) DARLING, H. C. R.: Chronic Gastritis. Med. Jour. Australia, **2,** 45–50, July 11, 1936.

(4) FINK, H.: Phlegmonous Gastritis. Am. Jour. Surg., **35,** 599–602, March, 1937.

(5) GIUNTOLI, L.: Gastrite tossica segmentaria dell'antro. Radiol. med., **17,** 853–856, July, 1930.

(6) HANSEN, K., and SIMONSEN, M.: Röntgenologische Beobachtung und Darstellung der allergischen Gastritis und des allergischen Pylorospasmus. Röntgenpraxis, **9,** 145–151, March, 1937.

(7) HOLMES, G. W., and SCHATZKI, R.: Examination of Mucosal Relief as Diagnostic Aid in Diseases of Gastro-intestinal Tract. Am. Jour. Roentgenol. and Rad. Ther., **34,** 145–157, August, 1935.

(8) LARIMORE, J. W.: The Significance of Chronic Gastritis. Am. Jour. Digest. Dis., **3,** 215–220, June, 1936.

(9) MONAGHAN, J. F., BOCKUS, H. L., KORNBLUM, K., and MOFFITT, G. R.: Gastric Secretory Behavior in Chronic Gastritis. Am. Jour. Digest. Dis., **3,** 655–666, November, 1936.

(10) PRÉVÔT, R.: Zur Röntgendiagnostik der Ätzgastritis. Röntgenpraxis, **8,** 372–375, June, 1936.

(11) REYNBERG, S. A.: Value of Roentgen Examination in Diagnosis of Chronic Gastritis. Sovet. vrach. gaz., **16,** 1267–1276, Aug. 30, 1935.

(12) SCHINDLER, R., ORTMAYER, M., and RENSHAW, J. F.: Chronic Gastritis. Jour. Am. Med. Assn., **108,** 465–468, Feb. 6, 1937.

(12-*a*) Idem: Clinical Symptoms of Chronic Gastritis: Observations on 35 Selected Cases. Arch. Int. Med., **60,** 143–153, July, 1937.

(13) SCHINDLER, R., and ORTMAYER, M.: Classification of Chronic Gastritis with Special Reference to

the Gastroscopic Method. Arch. Int. Med., **57,** 959–978, May, 1936.
(14) SIMPSON, C. KEITH: Observations upon Gastritis. Guy's Hosp. Rep., **85,** 102–125, January, 1935.
(15) STIX, W. H.: Chronic Gastritis. Jour. Med., **17,** 336–341, September, 1936.

DISCUSSION

B. A. RHINEHART, M.D. (Little Rock, Arkansas): I enjoyed Dr. Feldman's paper very much. I have a great respect for Dr. Feldman and Dr. Friedenwald because I have had occasion to quote several of their articles.

This paper reminds me of a statement of Alvarez that we should not be satisfied with pointing out beautiful morphological defects: we should get at the cause.

I believe that probably some day chronic gastritis will be shown to belong to that large group of diseases which we may class as degenerative diseases and which has been explored to a very slight extent so far. The pointing out of these morphological defects does not give us the cause. We may hold back research on such conditions by continuously examining these things by the x-ray and by the gastroscope.

If the cytological pathology of these lesions is examined carefully under the microscope, it will be seen to correspond very closely to what the experimental physiologists have found occurring in laboratory animals which have been kept on vitamin-deficient diets. The deficiencies of vitamin A, for instance, have promoted sloughing of epithelium in the gastro-intestinal tract. Deficiencies of vitamin B have promoted not only sloughing of the epithelium but hemorrhage into the mucosa, into the submucosa, and hemorrhage and fragmentation into the muscles with, of course, chronic changes. Deficiencies of vitamin C have caused a loss of cement substances between the cells with practically the same changes that vitamin B exhibits.

Naturally, any such lesion—duodenal ulcer, for instance—has a tendency to heal. Winkelstein has shown what causes duodenal ulcer and that even in the case of removal of the parathyroid glands duodenal ulcer will heal, but it heals slowly, so we may expect in lesions such as this that healing will be going on at the same time that ulceration goes on.

I think that in the future, probably when this subject is attacked from the nutritional standpoint, we shall begin to find out what is causing these conditions and what the cure is.

MAURICE FELDMAN, M.D. (*closing*): I wish to thank Dr. Cole[1] and Dr. Rhinehart for their discussions of my paper.

In the presentation of this paper, I have shown the various types of gastritis that one finds in the roentgen examination; I emphasized that it takes considerable experience to diagnose these conditions, and pointed out that the clinical observations are very important, because without consideration of the clinical and gastroscopic findings we cannot always make a diagnosis of gastritis.

In the two interesting cases of ulcerative gastritis, a markedly thickened gastric wall was found at operation—the gastric wall was about an inch and a half thick at the point of involvement. Histologic studies were made in both cases and hypertrophy of all the coats of the stomach was seen grossly and on microscopic examination. Definite gastritic changes were noted in both cases; although they simulated carcinoma, they proved to be cases of ulcerated gastritis.

The roentgen diagnoses of the two cases mentioned are exceedingly difficult to make without the clinical findings, and from the x-ray alone one would be readily misled. The films of both cases were seen by other roentgenologists and were diagnosed as carcinoma.

In the examination of the patient, by combining the history and the x-ray findings, a diagnosis of a benign lesion of an ulcerating gastritis type was made.

Regarding the hypertrophy of the lymph follicles, in my classification I placed this form under the type of follicular gastritis,

[1] Not returned for publication.

a form of gastritis which is impossible to diagnose by the x-ray. Mention was made of this form of gastritis in the classification because of anatomic changes.

As to the cause of gastritis which Dr. Rhinehart has pointed out, in many cases we cannot tell the cause unless a thorough history is taken of the case, but on the whole the etiology of gastritis has not been entirely explored. The cases that I present are specific types of gastritis; they are cases of gastritis of which we know the cause. Those of ulcerative gastritis were purely of inflammatory nature, and in the other cases a specific type of gastritis is shown.

As I mentioned in my paper, there are many different forms of gastritis and one has to be very careful in the diagnosis and classification of this disease.

NEW DEVICES

A SIMPLE APPARATUS FOR VISUALIZATION OF SINUS TRACTS[1]

By LEONARD LONG, M.D., Resident in Radiology, University of Wisconsin Medical School, *Madison, Wisconsin*

From the Department of Radiology and Physical Therapy, State of Wisconsin General Hospital, Madison.

One of the problems often faced by the roentgenologist is the visualization of draining sinus tracts. Treatment of these cases often presents an even greater problem to the surgeon, if he does not know the extent and communications of the tract.

The method usually followed, to fill larger sinus tracts with contrast solution, is through the use of a rubber catheter inserted into it. For small tracts, in which a catheter cannot be inserted, a blunt needle or small cannula is sometimes used with success.

The deficiencies of both these methods are soon apparent to anyone who tries them. The most important causes of failure are:

(1) Many tracts are so crooked that a catheter cannot be inserted into them even though their size seems adequate.

(2) The contrast solution often flows back toward the surface between the catheter and the sinus wall and escapes at the mouth of the sinus without outlining any of the tract beyond the tip of the catheter.

(3) Attempts to introduce a cannula or blunt needle into a very small tract, the direction of which one does not know, causes trauma and pain and sometimes results in the deposit of the contrast solution in the subcutaneous tissues.

(4) It is very difficult to keep the solution from draining out before the patient can be properly positioned and films exposed. The contrast solution which has leaked onto the skin surface obscures the tract and many times

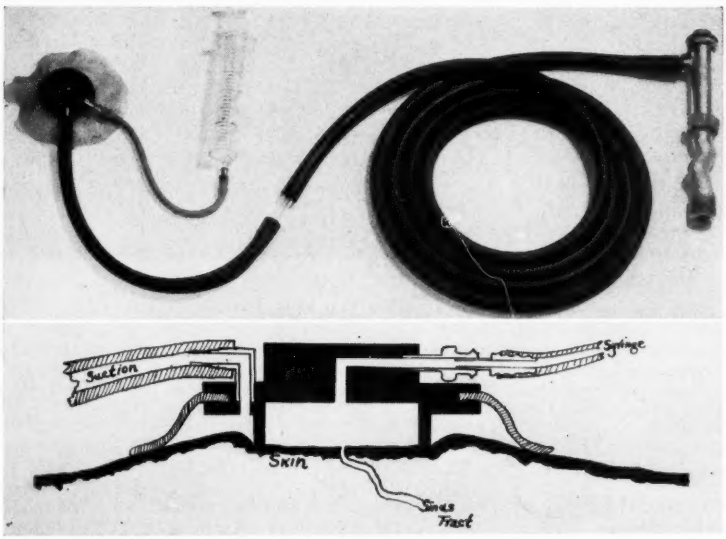

Fig. 1 (*above*). A shallow cup is connected by a small tube to a syringe filled with contrast solution. The cup is surrounded by a flange and rubber disc which form a vacuum chamber. An ordinary water vacuum pump is connected to this chamber by heavy-walled vacuum tubing.

Fig. 2 (*below*). Cross-section of the apparatus showing the central cup on the skin over the mouth of the sinus tract. The skin is pulled up around its edges by vacuum in the surrounding chamber, sealing it, and forming a direct path from the syringe to the sinus.

[1] Read before the general staff meeting, Jan. 17, 1939.

is confusing in interpretation, especially in single films.

(5) If the injection is made under fluoroscopic control, as it should be whenever possible, the catheter or cannula is easily displaced in rotating the patient for proper visualization in the different positions.

(6) More time is usually consumed in preparing for the injection than in the procedure itself and this not only takes up the operator's time but ties up the fluoroscopic room.

All of these factors, together with the mediocre results so often obtained, cause this valuable diagnostic procedure to be neglected. We therefore devised a very simple but effective apparatus for this purpose which has been found to overcome all the difficulties enumerated and makes the injection of a sinus tract almost as simple as administering a barium enema. The essential part of the apparatus was made by our mechanic, Mr. J. N. Hipple.

The apparatus consists of a small shallow cup about one-half inch in diameter which fits over the mouth of the sinus tract. This is surrounded by a flange and a soft rubber disc, about an inch wide, which form a shallow vacuum chamber around the cup. The central cup and the surrounding chamber open to the outside through separate outlets so designed that rubber tubes can be connected to them.

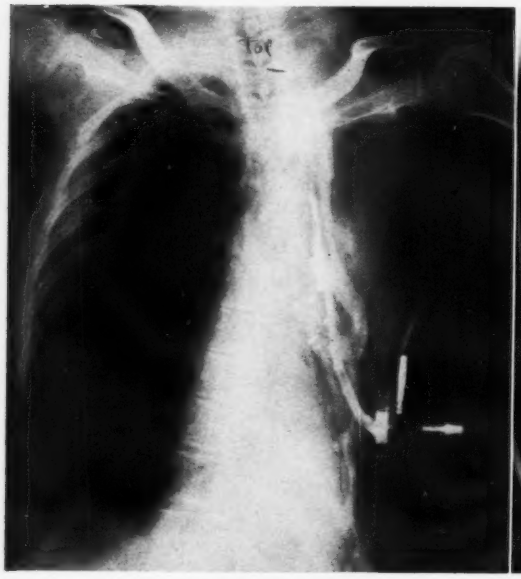

Fig. 3.

Fig. 4.

Fig. 3. Roentgenogram showing a sinus tract residual from a thoracoplasty injected by means of this apparatus. Note how effectively the solution is sealed in the cup at the mouth of the sinus.

Fig. 4. A small and crooked sinus tract which other methods had failed to fill satisfactorily. Note that a little of the contrast solution has leaked into the vacuum chamber because excessive pressure was used after the tract had been completely filled. Being readily observed at fluoroscopy, the injection was then stopped and the overflow automatically carried away by the suction. Thus no excess was left on the skin to obscure the roentgenogram.

Accessories consist of an ordinary water vacuum pump, a length of vacuum tubing, a syringe for contrast solution, and a small tube fitted with adaptors for connecting the syringe to the cup.

In operation, the patient is placed on the fluoroscopic table and the operator and assistant allow their eyes to become accommodated. The vacuum chamber outlet is then connected by a sufficient length of heavy-walled vacuum tubing to an ordinary water vacuum pump on the nearest tap. The central cup is then placed directly over the mouth of the sinus tract and the pump started. As the space under the rubber disc is evacuated the skin is pulled up snugly around the rim of the central cup, which is thereby sealed off. By a length of ordinary catheter tubing fitted with proper adaptors the syringe containing the contrast solution is now connected to the cup. The injection is made

under fluoroscopic control and the patient can be rotated freely to demonstrate to best advantage the direction and communications of the tract. When the filling is complete the syringe tube is closed off with a small clamp and the syringe removed. The vacuum is left on. The patient is then placed in the position found by fluoroscopy to demonstrate best the tract, and films are taken. Stereoscopic films are a decided advantage. The vacuum is now turned off, the cup drops off, and the solution runs out.

The tube connecting the syringe to the cup should be filled with the solution before connecting it to the cup in order to prevent trapping of air ahead of the contrast solution in the sinus tract.

A helpful but not absolutely necessary additional item is an elastic band which is passed around the body or extremity and over the cup to counteract the drag of the vacuum tubing and prevent accidental dislodgment of the cup during rotation of the patient in the dark.

The amount of pressure which can be used in the injection obviously is proportionate to the amount of vacuum holding the cup in place. No more injury to the skin than a slight ecchymosis has ever been observed following the use of this apparatus. It is conceivable, however, that more powerful vacuum pumps might produce injury and this should be carefully checked by experiment before use.

When very long sinus tracts, with many ramifications, are to be injected, it may be desirable to use the gravity method instead of a syringe and to allow a considerable time for the solution to reach all parts.

The apparatus is made of hard rubber, with the soft rubber disc cemented in place. It is sterilized by boiling. The tube connectors are placed at the edge in order to keep the cup flat and allow placing the part as near as possible to the film for the best radiographs. Being radiolucent (except the two small metal tube connectors), it does not obscure the sinus tract.

The ordinary water vacuum pump is recommended because most x-ray departments have a tap in or very near the fluoroscopic room.

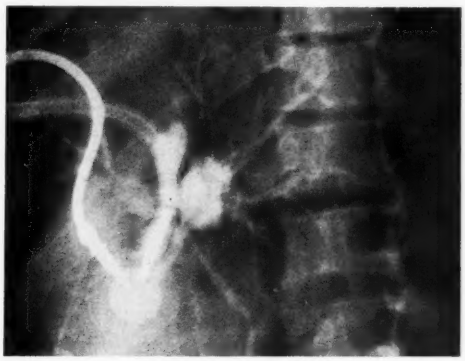

Fig. 5. Injection of biliary fistula showing perfect filling of the biliary system by means of this apparatus.

Also this type of pump is inexpensive and easily obtained. Other vacuum sources can, of course, be used if the vacuum is sustained and can be regulated. Some type of vacuum-measuring instrument is needed if the vacuum cannot be depended upon to remain at the optimum level.

The dimensions as given here are satisfactory for most cases. The same method could be used for extremely large openings, such as a colostomy, if a large cup were constructed. The rubber disc makes it possible to adapt the apparatus to rounded surfaces by merely molding the disc by hand until the vacuum has been established.

POINTS OF INTEREST

In drawing up plans for state-wide group hospitalization in **Michigan,** the following definition was established by the Michigan State Medical Society and the Michigan Hospital Association:

"It is agreed that the professional services of a doctor of medicine shall not be included in group hospital service programs. Technical services may be rendered as hereinafter defined: Technical services, in connection with hospital and medical service plans, are not considered professional medical services unless rendered directly by a doctor of medicine. Notwithstanding the above definition, it is agreed that the hospital program will not include any x-ray service."

* * *

On February 14 the Board of Trustees of the **American Medical Association** held a joint meeting in Chicago with representatives of the American Hospital Association. Purpose of the meeting was to seek solutions for some of the conflicts which seem to have developed between the organized hospital world and the organized medical profession in recent years, and to weld a bond of unity between the two allied groups. Resolutions adopted at the close of the meeting provided for similar meetings in the future and gave reason to hope for greater understanding and mutual support between hospitals and the medical profession.

* * *

Associated Hospital Service of **New York,** the largest group hospitalization plan in the country, and one which includes among its benefits certain medical services as a part of hospital care, suddenly announced a sharp reduction in payments to participating hospitals last month. Payments to hospitals, which formerly amounted to $15.00 for the first day of hospitalization and $20.00 for the second day, were reduced to $11.25 and $15.00, respectively. It is interesting to observe that the group hospitalization plan in Washington, D. C., which confines its benefits to hospital accommodation as recommended by the American Medical Association, was able last year to decrease its premium by 13 per cent and at the same time increase the number of days of hospital care provided.

The hospital insurance plan in Boston, which recently added radiology to its benefits with the allegation that mounting reserves warranted the extension of services, found it necessary to reduce its payments at the same time.

* * *

A state cancer hospital, built with WPA and state tax funds, is nearing completion in **Columbia, Missouri.** It is being built at a cost of $500,000. Beds will accommodate 90 patients. In addition, a clinic will be provided at the hospital to provide care for ambulatory cases.

* * *

At the request of a special committee of the State Medical Society, the **Kansas** Board of Medical Registration and Examination asked its attorney for an opinion concerning the right of non-medical practitioners to engage in the practice of radiology, either diagnostic or therapeutic. The following opinion was transmitted to the Board on April 7:

"It is my opinion, based upon a careful study of the statutes and the Supreme Court opinions, that roentgenology, either diagnostic or therapeutic, constitutes a practice of medicine and surgery as defined by the statutes of Kansas. Such practice when carried on by one not licensed to practise medicine and surgery is prohibited and unlawful.

"No rule of your Board can change these provisions of the statutes. Your Board could not, by rule, permit one not licensed as an M.D. to practise either branch of roentgenology, even if such practice was carried on under the direction of an M.D. The Board cannot, by rule, modify a statutory enactment. There may be, and undoubtedly are, certain technical operations connected with the practice of roentgenology that can be carried on by an unlicensed technician. Those operations, of course, could not include diagnostic or therapeutic work."

In consequence of this opinion, the Committee enacted the following resolution which was forwarded to the State Board of Medical Registration and Examination with the request that the Board adopt it as a part of its rules and regulations governing the practice of medicine in Kansas:

"Be It Hereby Resolved, That roentgenology, both diagnostic and therapeutic, is a specialized and technical branch of the practice of medicine, which in unskilled hands might be dangerous, and while it is recognized

there is a need for lay x-ray technicians as a means of assistance to the physician, these technicians should work only under the direct supervision of a doctor of medicine.

"BE IT FURTHER RESOLVED, That it is the consensus of the committee that all x-ray therapy should be administered under the personal supervision of a doctor of medicine."

* * *

The executive secretary of the Inter-Society Committee attended the regular meeting of the **Georgia Radiological Society** in Columbus on March 28. The Society adopted a resolution calling upon the Georgia State Medical Society to take stringent action against hospitals in the state which were engaging in the corporate practice of medicine.

Georgia radiologists maintain an active and sustained program in the field of medical economics through their state radiological society. Recently they were successful in securing an amendment to the state cancer law which permits private radiologists to treat state-aid patients. Formerly this work was confined to institutions.

Efforts are now being made to correct the state crippled children's law to provide a method for reimbursing radiologists who perform services on these patients. Fees for radiological services are now included in a *per diem* payment to approved hospitals.

As in other places, Georgia has had its troubles with hospital insurance. Repeated attempts have been made to install a group hospitalization plan which included radiology as a part of hospital care. The state society has not been idle, however, and at the present writing no such plan has been inaugurated. James J. Clark, M.D., is president.

* * *

The **Florida Radiological Society** held a special meeting on March 19, at Orlando, which was attended by the executive secretary of the Inter-Society Committee for Radiology. The Florida society is an active one and much has been accomplished during the last year or two in protecting and advancing the specialty in that state.

Repeated attempts have been made in several localities to add radiology as a hospital service to group hospitalization plans. Through the efforts of the Florida Radiological Society and with the full support of the county medical societies in the respective communities, these attempts have been defeated. H. O. Brown, M.D., is president.

* * *

Current reports indicate that the **Wagner Health Bill** will suffer a painless demise at the hands of the Senate Committee on Education and Labor without ever reaching the Senate floor. A wave of protest from physicians concerning the threat to the medical profession and the public health was matched by equally articulate protests from industry, which recognized that the fantastic sums required for the so-called National Health Program would prove to be the proverbial straw upon the aching backs of tax-strained business.

The Inter-Society Committee issued a special bulletin to all members of the four national societies on April 6 in regard to the Bill.

* * *

Anent the Vincent Bill introduced in the **New York** Legislature to prohibit the practice of radiology by laymen, the *New York Medical Week* published the following editorial comment in its issue of March 11:

"Those branches of medicine which employ non-medical technicians are most susceptible to lay encroachment. This is notably true in radiology, physical therapy, and clinical pathology . Lay technicians, dazzled by their ability to carry out certain routine procedures, forget they are not qualified to relate their findings to the human body. Laboratories operated by laymen attempt to diagnose, and in some cases treat, disease in violation of the letter and spirit of the Medical Practice Act.

"A bill sponsored by Assemblyman Vincent makes a direct and effective attack on the practice of radiology by unqualified persons. It requires radiological laboratories to obtain a municipal permit to operate and limits the issuance of such permits to physicians, dentists, and osteopaths. To prevent terminological controversies, it defines radiology as the diagnosis or treatment of disease by exposure to radium or roentgen rays.

"The Vincent Act leaves no loopholes for quacks who like to practice with a semblance of legality. By explicitly defining radiology and limiting its practice to physicians, dentists, and osteopaths, it effectively bars this important specialty to laymen with a degree of technical skill but insufficient knowledge of medical science to practice independently."

* * *

Arthur W. Erskine, M.D., President of the **Iowa State Medical Society,** arranged for radiological representatives to be present at a meeting on April 11, when the Iowa Hospital Association drew up plans for a state-wide group hospitalization plan. The plan was formally approved and adopted at a meeting

on April 24. Benefits are confined to hospital accommodations; radiology, anesthesia, and pathology are excluded.

* * *

At the annual meeting of the American Medical Association in San Francisco the House of Delegates directed the **Council on Medical Education and Hospitals,** together with the Bureau of Medical Economics, to draw up certain standards governing the practice of radiology, pathology, and anesthesia, as well as other medical services, in hospitals. Subsequently a special committee of the American College of Radiology, in collaboration with the Inter-Society Committee, began the preparation of a "Manual of Desirable Standards for Hospital Radiological Departments." Vincent W. Archer, M.D., is chairman of the College committee.

Tentatively completed, the *Manual* was submitted to the Council on Medical Education and Hospitals by the joint Committee at a meeting between the Inter-Society Committee and the Council during the St. Louis session. When finally agreed upon, the Committee hopes to have the official approval of the Council for the *Manual.* It will be printed to serve as a reference work for hospital administrators, radiologists, and others.

In discussing the *Manual* the joint Committee raised the question of the "Essentials for a Registered Hospital," used by the Council in approving hospitals. Section 7 of the "Essentials" now reads as follows:

"7. Radiology.—The hospital should provide or have ready access to radiological equipment and service. When a full time or part time physician-roentgenologist cannot be employed, the services of such a consultant should be secured. Radiologic interpretations must be made only by a competent roentgenologist. A description of the roentgenologic examinations should be placed in the patient's chart. The physician-roentgenologist preferably should be one who is a diplomate of the American Board of Radiology or a physician whose qualifications are acceptable to the Council on Medical Education and Hospitals of the American Medical Association."

At the request of the Committee, the Council has revised Section 7, subject to approval by the House of Delegates, as follows:

"7. Radiology.—*The responsibility for all radiologic examinations must rest on the physician-roentgenologist who is head of the department.* His findings and conclusions for all examinations should be placed in the patient's chart. Nothing in this provision should preclude additional study and interpretations by qualified attending physicians on the staff.

"The physician-roentgenologist should be preferably one who is a diplomate of the American Board of Radiology or a physician whose qualifications are acceptable to the Council on Medical Education and Hospitals of the American Medical Association.

"*It shall not be the policy of the hospital to make a profit from the department of radiology.*"

* * *

In refusing to review a decision of the **California** Supreme Court against the Pacific Health Corporation, the United States Supreme Court has again reaffirmed the doctrine that a corporation may not practise medicine. In rendering its decision the California Supreme Court ruled that the law forbidding the corporate practice of medicine applied to eleemosynary institutions as well as commercial enterprises. It was held that a corporation may not circumvent the law by hiring licensed physicians to render the actual medical service. By its action the Supreme Court of the United States leaves little room for debate about the legality of a corporation employing physicians to practise medicine.

MAC F. CAHAL
Executive Secretary

RADIOLOGICAL SOCIETIES IN THE UNITED STATES

Editor's Note.—Will secretaries of societies please cooperate with the Editor by supplying him with information for this section? Please send such information to Leon J. Menville, M.D., 1201 Maison Blanche Bldg., New Orleans, La.

CALIFORNIA

California Medical Association, Section on Radiology.—Chairman, Karl M. Bonoff, M.D., 1930 Wilshire Blvd., Los Angeles; *Secretary,* Carl D. Benninghoven, M.D., 95 S. El Camino Real, San Mateo.

Los Angeles County Medical Association, Radiological Section.—President, E. N. Liljedahl, M.D., 1322 North Vermont Ave., Los Angeles; *Vice-president,* M. L. Pindell, M.D., 678 South Ferris Ave.; *Secretary,* Wilbur Bailey, M.D., 2007 Wilshire Blvd.; *Treasurer,* Henry Snure, M.D., 1414 South Hope Street. Meets every second Wednesday of each month at County Society Building.

Pacific Roentgen Club.—Chairman, Lyell C. Kinney, M.D., San Diego; *Secretary,* L. Henry Garland, M.D., 450 Sutter Street, San Francisco. Executive Committee meets quarterly; Club meets annually during annual session of the California Medical Association.

San Francisco Radiological Society.—Secretary, L. H. Garland, M.D., 450 Sutter Street. Meets monthly on first Monday at 7:45 P.M., alternately at Toland Hall and Lane Hall.

COLORADO

Denver Radiological Club.—President, F. B. Stephenson, 452 Metropolitan Bldg.; *Vice-president,* K. D. A. Allen, M.D., 452 Metropolitan Bldg.; *Secretary,* E. A. Schmidt, M.D., 4200 E. Ninth Ave.; *Treasurer,* H. P. Brandenburg, M.D., 155 Metropolitan Bldg. Meets third Tuesday of each month at homes of members.

CONNECTICUT

Connecticut State Medical Society, Section on Radiology.—Chairman, Ralph T. Ogden, M.D., 179 Allyn St., Hartford; *Secretary-Treasurer,* Max Climan, M.D., 242 Trumbull St., Hartford. Meetings twice annually in May and September.

DELAWARE

Affiliated with Philadelphia Roentgen Ray Society.

FLORIDA

Florida Radiological Society.—President, H. O. Brown, M.D., 404 First National Bank Bldg., Tampa; *Vice-president,* H. B. McEuen, M.D., 126 W. Adams St., Jacksonville; *Secretary-Treasurer,* J. H. Lucinian, M.D., 168 S. E. 1st St., Miami.

GEORGIA

Georgia Radiological Society.—President, James J. Clark, M.D., Doctors Bldg., Atlanta; *Vice-president,* L. P. Holmes, M.D., University Hospital, Augusta; *Secretary-Treasurer,* Robert C. Pendergrass, M.D., Prather Clinic, Americus. Meetings twice annually, in November and at the annual meeting of the Medical Association of Georgia in the spring.

ILLINOIS

Chicago Roentgen Society.—President, David S. Beilin, M.D., 411 Garfield Ave.; *Vice-president,* Chester J. Challenger, M.D., 3117 Logan Blvd.; *Secretary-Treasurer,* Roe J. Maier, M.D., 7752 Halsted St. Meets second Thursday of each month, September to May, except December.

Illinois Radiological Society.—President, Cesare Gianturco, M.D., 602 W. University Ave., Urbana; *Vice-president,* Fred H. Decker, M.D., 802 Peoria Life Bldg., Peoria; *Secretary-Treasurer,* Edmund P. Halley, M.D., 968 Citizens Bldg., Decatur. Meetings quarterly by announcement.

Illinois State Medical Society, Section on Radiology.—The last meeting was May 2, 3, 4, 1939, held in Rockford. The officers of the Section for the meeting were Harry B. Magee, M.D., of Peoria, *Chairman,* and Warren W. Furey, M.D., 6844 Oglesby Ave., Chicago, *Secretary.*

INDIANA

Indiana Roentgen Society.—President, Stanley Clark, M.D., 108 N. Main St., South Bend; *President-elect,* Juan Rodriguez, M.D., 2903 Fairfield Ave., Fort Wayne; *Vice-president,* A. C. Holley, M.D., Attica; *Secretary-Treasurer,* Clifford C. Taylor, M.D., 23 E. Ohio St., Indianapolis. Annual meeting in May.

IOWA

The Iowa X-ray Club.—Holds luncheon and business meeting during annual session of Iowa State Medical Society.

MAINE

See New England Roentgen Ray Society.

MARYLAND

Baltimore City Medical Society, Radiological Section.—Chairman, Whitmer B. Firor, M.D., 1100 N. Charles St.; *Secretary,* Walter L. Kilby, M.D., 101 W. Read St. Meetings third Tuesday of each month.

MASSACHUSETTS

See New England Roentgen Ray Society.

MICHIGAN

Detroit X-ray and Radium Society.—President, Sam W. Donaldson, M.D., 326 N. Ingalls St., Ann Arbor; *Vice-president,* Clarence Hufford, M.D., 421 Michi-

gan Ave., Toledo, Ohio; *Secretary-Treasurer*, E. R. Witwer, M.D., Harper Hospital, Detroit. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society club rooms, 4421 Woodward Ave.

Michigan Association of Roentgenologists.—President, C. K. Hasley, M.D., 1429 David Whitney Bldg., Detroit; *Vice-president*, M. R. Cooley, M.D., Mercy Hospital, Jackson; *Secretary-Treasurer*, C. S. Davenport, M.D., 609 Carey St., Lansing. Meetings quarterly by announcement.

MINNESOTA

Minnesota Radiological Society.—President, Leo G. Rigler, M.D., University Hospital, Minneapolis; *Vice-president*, Harry M. Weber, M.D., Mayo Clinic, Rochester; *Secretary*, John P. Medelman, M.D., 572 Lowry Medical Arts Bldg., St. Paul. These officers will assume their duties after the Summer meeting which will be held in connection with the Minnesota State Medical Society, May 31 to June 2, 1939.

MISSOURI

The Kansas City Radiological Society.—President, L. G. Allen, M.D., 907 N. 7th St., Kansas City, Mo.; *Secretary*, Ira H. Lockwood, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Thursday of each month.

The St. Louis Society of Radiologists.—President, Paul C. Schnoebelen, M.D.; *Secretary*, W. K. Mueller, M.D., University Club Bldg. Meets on fourth Wednesday of October, January, March, and May, at a place designated by the president.

NEBRASKA

Nebraska Radiological Society.—President, T. T. Harris, M.D., Clarkson Memorial Hospital, Omaha; *Secretary*, D. Arnold Dowell, M.D., 117 S. 17th St., Omaha. Meetings first Wednesday of each month at 6 P.M. in Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY

(Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island.) *President*, Frank E. Wheatley, M.D., 520 Beacon St., Boston; *Secretary*, E. C. Vogt, M.D., 300 Longwood Ave., Boston. Meetings third Friday of each month from October to May, inclusive, usually at Boston Medical Library.

NEW HAMPSHIRE

See New England Roentgen Ray Society.

NEW JERSEY

Radiological Society of New Jersey.—President, Milton Friedman, M.D., 31 Lincoln Park, Newark; *Vice-president*, P. S. Avery, M.D., 546 Central Ave., Bound Brook; *Secretary*, W. James Marquis, M.D., 198 Clinton Ave., Newark; *Treasurer*, James Boyes, M.D., 744 Watchung Ave., Plainfield. Meetings at Atlantic City at time of State Medical Society, and Midwinter in Newark as called by president.

NEW YORK

Associated Radiologists of New York, Inc.—President, Henry A. Barrett, M.D., 140 East 54th St., New York City; *President-elect*, I. J. Landsman, M.D., 910 Grand Concourse, New York City; *Vice-president*, Frederic E. Elliott, M.D., 122 76th St., Brooklyn; *Treasurer*, Solomon Fineman, M.D., 133 East 58th St., New York City; *Secretary*, William J. Francis, M.D., 210 Fifth Ave., New York City. Regular meetings the first Monday evening of the month in March, May, October, and December.

Brooklyn Roentgen Ray Society.—President, Albert Voltz, M.D., 115–120 Myrtle Avenue, Richmond Hill; *Vice-president*, A. L. L. Bell, M.D., Long Island College Hospital, Henry, Pacific, and Amity Sts., Brooklyn; *Secretary-Treasurer*, E. Mendelson, M.D., 132 Parkside Ave., Brooklyn. Meetings first Tuesday in each month at place designated by president.

Buffalo Radiological Society.—President, Walter Mattick, M.D., 101 High St.; *Vice-president*, Chester Moses, M.D., 333 Linwood Ave.; *Secretary-Treasurer*, J. S. Gian-Franceschi, M.D., 610 Niagara Street. Meetings second Monday evening each month, October to May, inclusive.

Central New York Roentgen-ray Society.—President, W. E. Achilles, M.D., 60 Seneca St., Geneva; *Vice-president*, M. T. Powers, M.D., 250 Genesee St., Utica; *Secretary-Treasurer*, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse. Meetings held in January, May, and October as called by Executive Committee.

Long Island Radiological Society.—President, Samuel G. Schenck, M.D., Brooklyn; *Vice-president*, G. Henry Koiransky, M.D., Long Island City; *Secretary*, Marcus Wiener, M.D., 1430 48th St., Brooklyn; *Treasurer*, Louis Goldfarb, M.D., 608 Ocean Ave., Brooklyn. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

New York Roentgen Society.—President, Raymond W. Lewis, M.D., 321 E. 42nd St., New York City; *Vice-president*, Henry K. Taylor, M.D., 667 Madison Ave., New York City; *Secretary*, Roy D. Duckworth, M.D., 170 Maple Ave., White Plains; *Treasurer*, Eric J. Ryan, M.D., St. Luke's Hospital, New York City; *Member of Executive Committee*, E. Forrest Merrill, M.D., 30 W. 59th St., New York City. Meetings third Monday evening each month at Academy of Medicine.

Rochester Roentgen-ray Society.—Chairman, Joseph H. Green, M.D., 277 Alexander St.; *Secretary*, S. C. Davidson, M.D., 277 Alexander St. Meetings at convenience of committee.

NORTH CAROLINA

Radiological Society of North Carolina.—President, Robert P. Noble, M.D., 127 W. Hargett St., Raleigh; *Vice-president*, A. L. Daughtridge, M.D., 144 Coast

Line St., Rocky Mount; *Secretary-Treasurer*, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meetings with State meeting in May, and meeting in October.

OHIO

Cleveland Radiological Society.—President, John Heberding, M.D., St. Elizabeth's Hospital, Youngstown; *Vice-president*, R. V. May, M.D., St. Luke's Hospital, Cleveland; *Secretary-Treasurer*, Harry Hauser, M.D., City Hospital, Cleveland. Meetings at 6:30 P.M. at the Mid-day Club, in the Union Commerce Bldg., on fourth Monday of each month from October to April, inclusive.

Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).—*President*, B. M. Warne, M.D., Doctors Building, Cincinnati; *Secretary-Treasurer*, Justin E. McCarthy, M.D., 707 Race St., Cincinnati, Ohio. Meetings held third Tuesday of each month.

PENNSYLVANIA

Pennsylvania Radiological Society.—President, Charles S. Caldwell, M.D., 520 S. Aiken Ave., Pittsburgh; *First Vice-president*, Thomas L. Smyth, M.D., 111 N. 8th St., Allentown; *Second Vice-president*, Reuben G. Alley, M.D., Western Pennsylvania Hospital, Pittsburgh; *Secretary-Treasurer*, Lloyd E. Wurster, M.D., 416 Pine St., Williamsport; *President-elect*, Louis A. Milkman, M.D., 212 Medical Arts Bldg., Scranton; *Editor*, William E. Reiley, M.D., Clearfield. Annual meeting, June 2 and 3, 1939, Bedford Springs Hotel, Bedford, Penna.

Philadelphia Roentgen Ray Society.—President, Thomas P. Laughery, M.D., Germantown Hospital; *Vice-president*, Elwood E. Downs, M.D., Jeans Hospital, Fox Chase; *Secretary*, Barton H. Young, M.D., Temple University Hospital; *Treasurer*, R. Manges Smith, M.D., Jefferson Hospital. Meetings first Thursday of each month from October to May, Thompson Hall, College of Physicians, 19 S. 22nd St., 8:15 P.M.

The Pittsburgh Roentgen Society.—President, William B. Ray, M.D., 320 E. North Avenue, N. S. Pittsburgh; *Secretary*, Harold W. Jacox, M.D., 4800 Friendship Ave. Meetings held second Wednesday of each month at 4:30 P.M., from October to June at various hospitals designated by program committee.

RHODE ISLAND

See New England Roentgen Ray Society.

SOUTH CAROLINA

South Carolina X-ray Society.—President, Percy D. Hay, Jr., M.D., McLeod Infirmary, Florence; *Secretary-Treasurer*, Hillyer Rudisill, Jr., M.D., Roper Hospital, Charleston. Meetings in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association.

SOUTH DAKOTA

Meets with Minnesota Radiological Society.

TENNESSEE

Memphis Roentgen Club.—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

Tennessee State Radiological Society.—President, S. S. Marchbanks, M.D., 508 Medical Arts Bldg., Chattanooga; *Vice-president*, Steve W. Coley, M.D., Methodist Hospital, Memphis; *Secretary-Treasurer*, Franklin B. Bogart, M.D., 311 Medical Arts Bldg., Chattanooga. Meeting annually with State Medical Society in April.

TEXAS

Texas Radiological Society.—President, Jerome H. Smith, M.D., San Antonio; *President-elect*, C. F. Crain, M.D., Corpus Christi; *First Vice-president*, M. H. Glover, M.D., Wichita Falls; *Second Vice-president*, G. D. Carlson, M.D., Dallas; *Secretary-Treasurer*, Henry C. Harrell, M.D., 517 Pine St., Texarkana. Meets annually. Temple is place of next meeting.

VERMONT

See New England Roentgen Ray Society.

VIRGINIA

Radiological Society of Virginia.—President, Fred M. Hodges, M.D., 100 W. Franklin St., Richmond; *Vice-president*, L. F. Magruder, M.D., Raleigh and College Aves., Norfolk; *Secretary*, V. W. Archer, M.D., University of Virginia Hospital, Charlottesville.

WASHINGTON

Washington State Radiological Society.—President, H. E. Nichols, M.D., Stimson Bldg., Seattle; *Secretary*, T. T. Dawson, M.D., Fourth and Pike Bldg., Seattle. Meetings fourth Monday of each month at College Club.

WISCONSIN

Milwaukee Roentgen Ray Society.—President, H. W. Hefke, M.D.; *Vice-president*, Frederick C. Christensen, M.D.; *Secretary-Treasurer*, Irving I. Cowan, M.D., Mount Sinai Hospital, Milwaukee. Meets monthly on first Friday at the University Club.

Radiological Section of the Wisconsin State Medical Society.—Secretary, Russel F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

University of Wisconsin Radiological Conference.—Secretary, E. A. Pohle, M.D., 1300 University Ave., Madison, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.

EDITORIAL

LEON J. MENVILLE, M.D., *Editor* HOWARD P. DOUB, M.D., *Associate Editor*

SUPERVOLTAGE

Shortly after the present high voltage, *i.e.*, 200 kv. apparatus, was standardized some twenty years ago, the German school developed the "massive dose" technic. In this group Wintz, Friedrich, Dessauer, and others pioneered. The method employed large fields and prolonged exposures on the theory that cancer cells should be killed rapidly and that the normal cells in the direct beam of this intensive radiation would suffer less. It appears, however, that a few years' trial of this heroic measure revealed that much radiation sickness and untoward sequelæ developed, with little apparent gain in clinical results over more moderate methods, and the practice fell into disrepute.

In America, Pfahler was the first to introduce effective sustained radiation by his "saturation" method. This was soon copied by several of us and effected a compromise between the German single massive and the French fractional methods. Due to the great distances separating the pioneers in the United States and to the lack of ready contacts among them, they developed their own individualized technics, which, strange to relate, produced approximately similar results.

Regaud, Béclère, and Coutard were foremost among the French in the use of fractional dosage and multiple small fields and seemed to accomplish almost, if not quite, as much for the patient without the physical discomforts attending the German system.

Somewhat more recently, Chaoul, of Paris, claims to have obtained definitely superior results with his 60 kv. contact, non-filtered, fractionated procedure in superficial malignancies, and particularly in epithelioma of the mouth and cervix, and adenocarcinoma of the rectum.

One must not neglect to mention the ingenious x-ray achievement of the German Bucky with his Grenz or borderline tube excited by 10 kv. This has proved valuable in superficial lesions, both benign and malignant, but must be employed with particular care because it can be productive of damaging sequelæ despite extremely low penetrating powers. It must be borne in mind that Bucky rays are x-rays after all, irrespective of the fact that they are not far below the ultra-violet beam on the wave length scale.

As early as 1901, during the infancy of radiation therapy, we, on the West Coast, achieved some surprisingly favorable responses in both primary and secondary cancer cases, with static machine x-ray generators, despite our meager knowledge of radiation effects and dosage factors. Then came the era of spark-coil development, followed by dry and oil-insulated transformers which heralded the period of electro-physical standards, and the rapid advancement of knowledge that stabilized radiation therapy upon its present high professional plane. Many of the heroes in the early experimental period of x-ray development paid the supreme sacrifice of their lives in order that those who followed might carry on the work for the sake of humanity, protected from all the dangers which surround both their patients and themselves.

Allow us now to review briefly the immediate past and hazard some comments on the future prospects of radiation therapy. Early in January of the present year, in conversation with one of America's outstanding radiologists in New York City, the question of supervoltage radiation came up for serious consideration. This colleague was speaking in terms of multimillion volt possibilities, while we stoutly defended the present one-half million volt accomplishment as sufficient for present-day requirements. Finally, we compromised on one million volts as adequate for a suggested five-year period of experimental clinical research. That from 500 to 600 kv. apparatus has vantage points over 200 kv. is no longer debatable, but whether the available 1,000 kv.

apparatus is superior to the 600 kv. we cannot yet be so sure. This statement is based upon a comparison between the results obtained with our own Tumor Institute's 600 kv. plant and those of the 1,000 kv. installation at the California Institute of Technology under the direction of Dr. R. A. Millikan, Dr. C. C. Lauritsen, and Dr. Seeley Mudd.

Our 600 kv. generator emits effective radiation from the tube at 550 kv., while the equipment at Pasadena has been run at from 500 kv. to 1,200 kv. effective. Both institutions use the Lauritsen open-tube method, and, strangely enough, the graph of the depth dose curve for both tubes flattens out at approximately the same level, despite their differences of potential.

From physical deductions, it does not appear that the 400 kv. apparatus can rightfully be classed in the "supervoltage" category, as gamma x-rays at this voltage are not in preponderance.

Regarding the appellation "supervoltage," this term has not been favorably received in various centers. Perhaps it would be better after all to discontinue reference to Grenz rays, soft and hard rays, surface and deep rays, long and short waves, etc., and, instead, when reporting on x-ray therapy, to state exactly the effective voltage employed. By effective voltage we do not mean the peak potential of the high voltage generator; rather, the voltage corresponding to the effective wave length of the emitted radiation. This would do away with much confusion and misunderstanding and go a long way toward standardizing our literature on radiation therapy.

ALBERT SOILAND, M.D.

ANNOUNCEMENTS

THE AMERICAN SOCIETY OF X-RAY TECHNICIANS

The American Society of X-ray Technicians will hold its fourteenth Annual Meeting at the McAlpin Hotel, New York City, June 27 to 30, inclusive.

Many interesting and instructive contributions will be presented at this meeting, on technical subjects, affording the x-ray technicians an unusual opportunity to acquaint themselves with the most modern methods employed in x-ray technic.

ANNOUNCEMENT

In the forthcoming numbers of RADIOLOGY there will appear a group of articles contributed in honor of I. Seth Hirsch, M.D. It was the desire of his pupils, associates, colleagues, and co-workers so to mark the thirty-fifth anniversary of his activity in radiology. The valuable contributions which the following issues will contain will constitute a milestone measuring radiological progress.

We are grateful to the Editor of RADIOLOGY for joining in this deserved tribute to one whose services to radiology and loyalty to the Journal have been so outstanding.

CURRIER MCEWEN, M.D., Dean, New York University College of Medicine;
CHARLES GOTTLIEB, M.D., Assistant Professor of Radiology, New York University College of Medicine;
RICHARD A. RENDICH, M.D., Director, Division of Radiology, Department of Hospitals, New York City;
MILLS STURTEVANT, M.D., Professor of Clinical Medicine, New York University College of Medicine;
HENRY K. TAYLOR, M.D., Director, Department of Radiology, Welfare Hospital;
MAXWELL H. POPPEL, M.D., Roentgenologist, King's County Hospital, *Chairman.*

The Committee

IN MEMORIAM

HENRY SCHMITZ, M.D. (1871–1939)

The death of Dr. Henry Schmitz brought to an untimely end the career of a pioneer in radiation therapy. His counsel in this particular field of medicine will be greatly missed by all of us. Everyone whose privilege it was to have known Dr. Schmitz will mourn his passing.

Dr. Schmitz was born in Kaiserswert, Germany, Dec. 26, 1871, the son of John Mathias and Gertrude (Pollender). He came to this country early in life, and on Nov. 17, 1897, was united in marriage with Meta Elizabeth Lenzen, of Chicago.

Dr. Schmitz was graduated from the Loyola University Medical School, in Chicago, Illinois, in 1897, and was connected with his alma mater ever since. At the time of his death, he was Professor of Gynecology and Head of the Department. Active in organized

The late HENRY SCHMITZ, M.D.

medicine, he was a member of many associations, both in gynecology and radiology. In the treatment of carcinoma, especially carcinoma of the uterus, Dr. Schmitz played a very important rôle, and is probably best known to radiologists for his contributions on this subject. Through his untiring efforts, the Institute of Radiation Therapy was founded in Chicago in 1933, in the development of which Institute he spent much time and effort. He was a prolific writer. His articles displayed his frankness, painstaking precision, and contained many original ideas. He was the author of a number of important text-books such as: "Manual of Gynecology," the English translation of Kroenig and Friedrich's "Physics and Biology of Radiation Therapy," and many others. It would be impossible to enumerate here all of Dr. Schmitz' activities and innumerable contributions in the field of medical science.

Dr. Schmitz was past president of the American Radium Society, and also an active member of the Radiological Society of North America. During the first American Congress of Radiology, Dr. Schmitz acted as treasurer of the organization and his counsel was of the utmost importance to the success of the Congress.

He was well known and esteemed both here and abroad, and had a great many friends in radiology. He was a man who typified the best qualities of the German, and by close association his unusual traits became evident. The better acquainted one became with Dr. Schmitz, the more one appreciated his strength of character. His fairness is exemplified by his attitude toward candidates for examination, especially on the American Board of Radiology. While on the surface he may have appeared brusque, in later discussions of the candidates, his fairness to and his interest in them became evident.

Medicine, particularly radiology, has lost a great physician. We join with Mrs. Schmitz and his three sons who survive him in this, their time of great bereavement, and extend to them our deepest sympathy.

EDWARD L. JENKINSON, M.D.

BYRON H. JACKSON, M.D.

The Editor has received the sad news of the passing of Byron H. Jackson, M.D., an honored member and past president of the Radiological Society of North America.

A memorial sketch and portrait of Dr. Jackson are being prepared for a forthcoming issue of RADIOLOGY.

BOOKS RECEIVED

Books received are acknowledged under this heading, and such notice may be regarded as an acknowledgment of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

RÖNTGENATLAS DER ERKRANKUNGEN DES HERZENS UND DER GEFASSE (Roentgen Atlas of Diseases of the Heart and Vessels). An Introduction for Physicians. By Dr. WALTER BREDNOW, Professor of Internal Medicine and Roentgenology, Chief Physician at the Medical Clinic, University of Göttingen. Second, enlarged and improved, edition, containing 161 pages, with 90 illustrations. Published by Urban & Schwarzenberg, Berlin, 1939. Price: 10.50 R.M.; 12 R.M., bound.

ELEKTRODIAGNOSTIK (Electrodiagnosis). By Dr. B. NEOUSSIKINE and Dr. D. ABRAMOWITSCH, Tel Aviv. A volume containing 242 pages, with 42 illustrations. Published by Hans Huber, Bern, Switzerland, 1939. Price: 12 francs or 7.20 R.M.

ABSTRACTS OF CURRENT LITERATURE

CONTENTS BY SUBJECT

THE FOLLOWING ABSTRACTORS HAVE CONTRIBUTED TO THIS ISSUE

S. M. ATKINS, M.D., of Waterbury, Conn.
S. RICHARD BEATTY, M.D., of Denver, Colo.
M. L. CONNELLY, M.D., of Chicago, Ill.
BENJAMIN COPLEMAN, M.D., of Perth Amboy, N. J.
PERCY J. DELANO, M.D., of Chicago, Ill.
SYDNEY J. HAWLEY, M.D., of Danville, Penna.
LEWIS G. JACOBS, M.D., of Winona, Minn.
MAX MASS, M.D., of Chicago, Ill.
JOHN G. MENVILLE, M.D., of New Orleans, La.
JOHN M. MILES, M.D., of Lafayette, La.
R. R. NEWELL, M.D., of San Francisco, Calif.
LESTER W. PAUL, M.D., of Madison, Wis.
HAROLD O. PETERSON, M.D., of Minneapolis, Minn.
ERNST A. POHLE, M.D., Ph.D., of Madison, Wis.
SIMON POLLACK, M.D., of Chicago, Ill.
C. W. REAVIS, M.D., of Detroit, Mich.
ERNST A. SCHMIDT, M.D., of Denver, Colo.

ABSTRACTS IN THIS ISSUE LISTED ALPHABETICALLY BY AUTHORS

ANEURYSM

An Instructive Case of Aneurysm of the Heart Wall with "Teeter-movement" Symptom. L. Bischoff. Schweiz. med. Wchnschr., **68,** 1415, 1416, Dec. 31, 1938.

The author reviews the literature on cardiac aneurysm as a result of cardiac infarction. He reports a case with typical electrocardiographic signs of anterior wall infarct, which repeatedly showed clinically a pulsation of the outer chest wall in the left third interspace, somewhat within the mammary line. This pulsation moved synchronously but paradoxically with the heart impulse. On account of tachycardia, it had a tic-tac rhythm with a slightly prolonged inward phase. The author coins the name "*gigampfisymptom*" (teeter-movement symptom) for this sign, and believes it to be pathognomonic of a left wall cardiac aneurysm. In his case, roentgen confirmation of the diagnosis was obtained.

LEWIS G. JACOBS, M.D

Clinical Aspects of Aneurysm. John H. Mills and Bayard T. Horton. Arch. Int. Med., **62,** 949–962, December, 1938.

A statistical study of the 596 cases of aneurysm which were observed at the Mayo Clinic during the ten-year period from 1925 to 1935 is presented. These cases are classified anatomically into intracranial, intrathoracic, intra-abdominal, those of the extremities, and miscellaneous. In other than those of the thoracic aorta, in which it ascends to 70 per cent, syphilis is negligible as an etiologic agent.

Roentgen examination is of benefit as a diagnostic aid in aneurysms of the intracranial group, particularly if calcification is present. However, this may be easily mistaken for that which may occur in a calcified cyst or tumor. Erosion of the bony processes in the area of the aneurysm may be noted. If rupture occurs, there may be ventricular displacement.

The authors discuss statistically the location, etiology, and in the intracranial and intrathoracic groups, the symptoms and diagnosis of these aneurysms. A total of 172, or 28.9 per cent, were verified at operation or autopsy.

C. W. REAVIS, M.D.

APPARATUS

Stratigraphy of the Lungs and Bones. Delaborde. Bull. et mém. Soc. de radiol. méd. de France, **26,** 503–506, July, 1938.

Several cases are presented, demonstrating the additional information to be obtained from stratigraphy. The apparatus manufactured by the Compagnie Generale de Radiologie, marketed under the name "Stratix," is described in considerable detail. This is an apparatus in which the tube and film carrier are coupled with a lever which allows vertical movement, in opposite directions, of the tube and film. Adjustments for height, distance of tube from film, selection of the plane desired for stratigraphy, and automatic timing are built-in. A fluorescent screen permits accurate centering and selection of the plane to be radiographed. A movable anti-diffusion grid is included. The tube may be uncoupled for ordinary radiography. The "Stratix" is an apparatus combining simplicity and accuracy.

S. R. BEATTY, M.D.

Modern High Milliamperage and High Voltage Apparatus for Roentgen Deep Therapy. W. Fehr. Strahlentherapie, **64,** 341, 1939.

The author describes briefly a 200 kv. deep therapy apparatus which permits a tube current up to 30 ma. using a water-cooled Metalix tube. The power plant uses a Villard circuit. Another unit making use of the cascade circuit of Greinacher can be operated at 1,000 kv. and 1 ma. Illustrations of the units are shown.

ERNST A. POHLE, M.D., Ph.D.

Two Radiographic Teaching Models. W. E. Boyd. British Jour. Radiol., **11,** 444–451, July, 1938.

Two models are described, one a flat board in which are inserted rows of thumb tacks in a vertical and horizontal direction; the other a block made up of 10 layers of plywood, each 14 inches square and one inch thick. In each layer a row of thumb tacks were placed, so that when the layers were bolted together the rows in different layers were at different distances from the center. These models are very useful for demonstrating distortion and enlargement, and also the effect of angulation of the beam with reference to the film.

S. J. HAWLEY, M.D.

The Standing and Prospects of Miniature Photographs from the Roentgen Screen. H. Holfelder and F. Berner. München. med. Wchnschr., **85,** 1818–1823, Nov. 25, 1938.

The authors review the history of miniature roentgenography. With their apparatus (Siemens-Reiniger, with a Zeiss Ikon camera), they can make from 300 to 350 chest examinations an hour, in serial surveys. The resulting films are satisfactory for diagnosis, showing the lesion in all cases. Enlargements may be made, but are found to be not so sharp as good roentgenograms. The authors used the method for detecting disease, and in positive cases made the final diagnosis on the basis of standard roentgenograms. They use 24 sq. mm. for the miniature films.

From an eugenic standpoint, it is desirable to keep the amount of irradiation down. Using a piece of film in a box, out of the line of direct exposure, directly beneath the fluoroscopic screen, it was found that, after 1,200 exposures, development produced only the least fog, while a similar test at fluoroscopy showed complete blackening of the film.

For practical evaluation, 10,732 films were taken; of these, 134 were discarded because they could not

be used for diagnosis. The usual procedure of varying the lighting intensity and distance of viewing, which applies to full size films, was not found practical with miniatures. After a little practice, the authors feel that up to 500 films an hour can be examined. The correct diagnosis can be made from the miniature in all cases.

Of the 10,598 films studied, 93.1 per cent were normal, 4.5 per cent had pulmonary calcifications, 0.8 per cent had recent and not definitely healed tuberculosis, 0.07 per cent had tuberculosis with cavity, 0.05 per cent had various cardiac abnormalities, and 0.09 per cent had other abnormalities. No case of bronchiectasis was diagnosed in the series, as its signs were not definite on the miniatures.

The authors think that improvement of apparatus is needed, especially in the direction of short exposure condenser units for generating the rays. After some discussion of roentgen cinematography, the difficulties of the method are indicated, such as the necessity for perfect focusing of the camera, which, in turn, requires an unusually stable arrangement of the apparatus. The cost of the apparatus partly offsets the cheapness of the films. Regular roentgenography still remains the method of choice for study of single cases of disease, and miniatures are useful only in serial surveys. While the method has been developed for the lungs, it is naturally possible to use it in similar fashion for other organs.

LEWIS G. JACOBS, M.D.

Presentation of the Biotome of Bocage and of the Planigraph of Ziedses des Plantes. J. Massiot. Bull. et mém. Soc. de radiol. méd. de France, **26,** 520–523, July, 1938.

The author briefly describes the apparatus of Ziedses des Plantes for planigraphy, utilizing circular or epicycloidal movement of the tube and film, and that of Bocage, which employs only the circular movement.

The apparatus of Ziedses des Plantes is adapted to radiography of the subject in the horizontal position and is, therefore, not of use when fluid levels exist. The biotome of Bocage requires that the subject be upright. The other advantages and disadvantages of each apparatus are mentioned.

S. R. BEATTY, M.D.

Internal Targets in the Cyclotron. Robert R. Wilson and Martin D. Kamen. Phys. Rev., **54,** 1031–1036, Dec. 15, 1938.

Radio-phosphorus is promising in therapy and radio-iron valuable in physiological research. They are made by bombarding ordinary phosphorus, atomic weight 31 and iron of atomic weight 58 (rare isotopes), with high speed deuterons. Working at about eight million electron volts, the Berkeley cyclotron requires a day to produce enough radio-phosphorus for use in therapy. Their best concentration of radio-iron was one microcurie per 30 milligrams iron (two weeks' bombardment). By putting a target of iron phosphide on a "probe" into the interior of the cyclotron these yields could be increased several times, and without diminishing the beam of deuterons in the target chamber (being used for physical research) by more than 10 per cent. They produced iron of 0.5 microcurie activity per milligram by using pure iron on the probe.

R. R. NEWELL, M.D.

Practical Pulmonary Stratigraphy. C. Gaillard. Jour. de med. de Lyon, **19,** 643–647, Nov. 5, 1938.

Pulmonary stratigraphy is, in the opinion of the author, a valuable diagnostic method furnishing information unobtainable with ordinary methods of radiography.

It is possible to obtain excellent stratigraphs by modifying standard apparatus. The author describes his apparatus in some detail and presents examples of the films secured. Several directions of motion of the tube and film are possible. The diagrams alone will suggest the basic adaptations necessary. Such an apparatus should be inexpensive to construct and simple and accurate in operation.

S. R. BEATTY, M.D.

The Distribution of the Dose in Near-distance X-ray Tubes and Body Cavity Tubes of Various Constructions. T. Zimmer. Strahlentherapie, **64,** 348, 1939.

The author describes several models of the near-distance x-ray tube operating at 60 kv. and used according to the method developed by Chaoul. A series of depth dose and isodose charts are shown, as well as illustrations of two different models. One tube is especially designed for the treatment of small body cavities at 60 kv. and 2 ma. It delivers 330 r/min. at 1 cm. focus chamber distance.

ERNST A. POHLE, M.D., Ph.D.

ASBESTOSIS

Asbestosis. J. V. Sparkes. British Jour. Radiol., **11,** 371–377, June, 1938.

Pulmonary asbestosis gives a different clinical, pathologic, and radiologic picture to most other forms of pneumoconiosis, because of the different nature of particles inhaled. Asbestos consists of long silky fibers, as silicate of iron and magnesium without free silica. The shape of the particles causes them to be stopped in the terminal bronchioles where a deposit of iron-containing material forms over them. These are called "asbestos bodies." They are readily demonstrated in the sputum.

The symptoms—dyspnea, cough, anorexia, lassitude, chest pain, and weight loss—are more pronounced than physical signs or roentgen-ray findings.

The roentgen-ray appearances, which are typical only when the lesion is advanced, are restriction of diaphragmatic movement; hazing of diaphragm; clouding of costophrenic angles, which may extend along the cos-

tal margin toward the apices. The heart outline is poorly defined, and there is occasional prominence of the pulmonary artery. The lung-fields show a relative increase in density in basal portions due to lack of aeration, described as "ground-glass appearances." There is a patchy increase in density throughout the lungs, but no nodulation.

The chief complications of asbestosis are: (1) recurrent bronchitis; (2) bronchopneumonia; (3) tuberculosis, and (4) carcinoma.

S. J. HAWLEY, M.D.

ASTHMA

Roentgen Studies of the Pathological Physiology of Bronchial Asthma. Leo G. Rigler and Rudolph Koucky. Am. Jour. Roentgenol. and Rad. Ther., **39,** 353–362, March, 1938.

Bronchographic and pathologic studies give rise to a concept of bronchial asthma and the asthmatic attacks as follows: the disease affects primarily the bronchial mucosa, producing an enormous hypersecretion of mucus which accumulates within the lumina of the bronchi. Due possibly to stasis from spasm of the bronchial muscle to marked viscosity, or to other factors, this mucus forms a plug or core, partially obstructing the bronchus so that air may be inspired past the occlusion, but is expelled much less readily. Emphysema is thus produced. During the asthmatic attack the spastic muscle clamps down around the plug, aggravating the occlusion.

Roentgen observation on living cases of bronchial asthma, by means of bronchography, demonstrates clearly the presence of these occlusive plugs during life and indicates that they are an integral part of the disease process in bronchial asthma.

Bronchography is of great value in elucidating the nature and extent of the process in individual cases and in giving some determination of the prognosis.

S. M. ATKINS, M.D.

BACKACHE

Lumbosacral Anomalies as a Cause of Low Backache. Wright Clarkson and Allen Barker. South. Med. Jour., **31,** 515–520, May, 1938.

Developmental anomalies of the lumbosacral spine may be a cause of low back pain by creating an unstable joint, placing undue strain on ligaments, joints, and muscles.

More significant and frequent are those cases with a narrowed lumbosacral joint and a resulting subluxation of the lumbosacral articular facets. Herniation of the nucleus pulposus into the spinal canal, with pressure on nerve roots, may be responsible for low back and sciatic pain as well as for the narrowed disk, but the pain may be due to increased tension upon the capsular ligaments or impingement of the ends of the articular processes upon the pedicles above and the lamina below. The thinning of the disk may be due to senile degeneration or repeated trauma. Vague abdominal complaints, such as atypical gall-bladder pain, may be the result of vertebral defects.

Anteroposterior and lateral roentgenograms are made with the central ray in the anteroposterior view passing vertically between the fifth lumbar and first sacral segment.

JOHN M. MILES, M.D.

Low Back Pain in Relation to Urology. Stanley F. Wildman. Jour. Okla. St. Med. Assn., **31,** 35–38, February, 1938.

It is the author's contention that 75 per cent of backache in men is due to genito-urinary pathology and 50 per cent in women is gynecologic. Branches of the same nerves that supply the sacro-iliac joints go to the prostate, seminal vesicles, and rectum. Pain due to pelvic pathology may be referred to the sacro-iliac joints.

So-called sacro-iliac sprain is often due to a prostato-seminal vesiculitis and many people draw compensation for sprain when their trouble is of genito-urinary origin.

JOHN M. MILES, M.D.

Intractable Low Back and Sciatic Pain Due to Protruded Intervertebral Discs: Diagnosis and Treatment. J. Grafton Love. Minnesota Med., **21,** 832–839, December, 1938.

The author stresses the fact that ordinary roentgenography fails, in the vast majority of cases, to give a clue to the real pathologic condition which underlies the patient's disability in certain cases of low back pain. To-day, laminectomy for the removal of protruded intervertebral discs is one of the commonest neurosurgical operations performed at the Mayo Clinic. The anatomy of the discs is reviewed in this article. They occur throughout the spinal column from the space between the second and third cervical vertebræ to the coccyx. Those in the sacrum and coccyx are rudimentary and are rarely protruded. Certain areas are vulnerable, the lumbar particularly so.

True protrusions are most often the result of strain. Many of the patients with protrusions have anomalies of the spine such as sacralization, fusion failure, and facet anomalies. About 25 per cent of the patients are unable to recall any injury. The majority of protrusions occur laterally (the central part of the posterior longitudinal ligament is strongest and there are deficiencies laterally) and thus the unilaterality of symptoms is explained.

The tissue contains both nuclear and annular material and hence the term "protruded disc" is preferred to "herniated nucleus pulposus" and "rupture of the intervertebral disc." The symptoms, which vary with the location and the degree of protrusion, are reviewed.

Laboratory tests include examination of the spinal fluid for protein content, which is elevated, usually above 40 mg. per 100 c.c. Subarachnoid block on

puncture is rare; when it exists, paralysis is usually present also. If lesions are caudal the reversed Queckenstedt test is positive.

Roentgenography begins with fluoroscopy, after subarachnoid injection of 5 c.c. of lipiodol. It should never be used in presence of suspected inflammatory lesions; never at temperatures above that of the body; never if it is cloudy, and usually through the second or third lumbar interspace. Introduction at the level of the protruded disc may be painful.

The filling defect is usually anterolateral. Sometimes the enlarged shadow of the edematous nerve root is detected. Recently, defects due to hypertrophy of the ligamentum flavum have been recognized. Sometimes the ligamentum flavum is alone at fault. The treatment is surgical.

PERCY J. DELANO, M.D.

THE BLADDER

Dermoid Cyst of the Bladder. A. Lidzki. Ann. Surg., **109,** 274–276, February, 1939.

A paravesical dermoid cyst in a female, 30 years of age, which opened into the bladder, is reported in this article. Roentgenologic examination showed two shadows in the pelvis which proved to be a stone and a hair ball, lodged in the diverticulum. The cyst became practically obliterated when the fistulous tract was dilated and its contents removed.

JOHN G. MENVILLE, M.D.

The Radiological Diagnosis of Bladder Tumors. Waclaw Sitkowski. Polski Przegl. Radiol., **13,** 153, 1938.

The author employs a double-contrast method in the diagnosis of bladder tumors. First a barium sulphate solution is injected, and later, after evacuation of the barium solution, air is insufflated. The formula for the barium solution is given as: barium sulphate, 20 grams; gelatin, 2.5 grams, and distilled water, 100 grams.

The roentgenograms obtained by this method present the details of the bladder outlines in good contrast.

ERNST A. SCHMIDT, M.D.

The Avoidance of Injurious Effects on the Bladder in Radiation Therapy of Carcinoma of the Uterus. T. C. Neeff and F. Hoff. Strahlentherapie, **64,** 113, 1939.

The adequate treatment of advanced carcinoma of the uterus requires the application of high doses which reach the upper limit of tolerance of both the rectum and the bladder. A computation of the total dose effective in the bladder wall, including both x-ray treatment and intra-uterine radium application, gave as mean value 7,000 r. This is administered during a period of approximately four weeks, following the authors' method. Numerous cystoscopic studies have established this value as the tolerance dose for the bladder mucosa. There are, however, some patients who, with this dose, develop edema, granulations, small ulcers, and telangiectasis in the bladder wall. No serious permanent injuries have been observed, if the total dose was carefully kept within that range.

The authors also describe a method of cystoscopic color photography. They succeeded in obtaining photographs with exposure times of from one-tenth to one-twentieth of a second. The accompanying illustrations (in color) are excellent.

ERNST A. POHLE, M.D., Ph.D.

Roentgenologic Diagnosis of Placenta Previa: Indirect Placentography. Walter H. Ude, J. A. Urner, and O. F. Robbins. Am. Jour. Roentgenol. and Rad. Ther., **40,** 37–43, July, 1938.

An increase of more than one centimeter in the space between the presenting part and the bladder, in the third trimester, especially in the last two months, is strong evidence of placenta previa. Fecal or gas distention, which normally may increase the width of this space, is eliminated by low colonic flushes.

The central type practically always displaces the presenting part upward over the entire upper surface of the bladder, while the partial type usually depresses one of the lateral horns of the bladder and displaces the presenting part somewhat toward the opposite side.

Technic.—The urinary bladder is catheterized and from 25 to 40 c.c. of a contrast solution is instilled. After withdrawal of the catheter, a compression band for stabilization of the abdomen is applied and an anteroposterior view of the abdomen in the prone position is made. A lateral and oblique view may be taken in addition.

Of the last 44 cases of abnormal bleeding in the third trimester examined, 39 were diagnosed negative, four placenta previa of the central type, and one of the partial. Clinically, 40 were negative, three central placenta previa, and one partial. The roentgen examination alone is not sufficient but must be combined with the clinical. Blood clots in the lower uterine segment, though rare, may simulate the roentgen findings of this condition.

S. M. ATKINS, M.D.

BRONCHIECTASIS

The Rôle of Inflammatory Bronchial Stenosis in the Etiology of Bronchiectasis. Paul H. Holinger. Ann. Otol., Rhinol., and Laryngol., **47,** 1070–1082, December, 1938.

Obstruction of a bronchus is now recognized as the chief cause of acquired atelectasis. Anspach has previously reported a series of 50 cases, taken from a group of 100, in which a triangular shadow had been observed at the base of one or both lungs for periods up to 12 years. Such shadows and findings frequently led to a diagnosis of pneumonia, unresolved pneumonia, mediastinal or interlobar empyema, or atelectasis. Anspach correlated the triangular shadow with atelec-

tasis and demonstrated by serial x-rays and post-mortem studies that bronchiectasis developed in the atelectatic areas if they remained atelectatic. During the past two and one-half years, a majority of these cases have been studied again and additional information has been gained regarding the intrabronchial pathology. Inflammatory bronchial stenosis was found to be responsible for the production of the original pulmonary lesion, atelectasis. The author uses the term "prebronchiectasis" to describe the condition at this stage, before definite bronchiectasis has developed. At this time the lesion is characterized, clinically, by an area of dullness, bronchial breathing, râles, a chronic cough, and a low-grade elevation of temperature which may have followed an upper respiratory infection or a so-called pneumonia. Persistence of such findings is of utmost significance, since x-ray examination reveals evidence of atelectasis.

The bronchoscopic picture is that of an acutely inflamed bronchial orifice, stenotic, from which pus oozes without bubbling. By shrinking the mucous membrane around the stenosed orifice with cocain, or by dilating it with forceps and then passing an aspirator directly into the orifice, pus can be released and normal function can eventually be restored. Subsequent lipiodol instillation reveals a normal bronchial tree. If untreated, this type of case eventually develops bronchiectasis. In cases of atelectasis of longer duration an attempt should be made bronchoscopically to open the airway and permit better drainage of pus, although there may be no hope of restoring normal function. In some cases in which atelectasis had been present for more than a year, there were definite bronchiectatic cavities with marked lung destruction.

LESTER W. PAUL, M.D.

Bilateral Lobectomy for Bronchiectasis. Dudley E. Ross. Canadian Med. Assn. Jour., **39**, 549–552, December, 1938.

Unilateral lobectomy for bronchiectasis has now become a common operation. The mortality rate reported by various authors is approximately 10 per cent. Bilateral lobectomies, on the other hand, have been infrequent, only nine being reported, with one death. The author reports in detail two additional successful cases.

The author believes the most important single factor affecting the death rate in bilateral lobectomy is the stage of the disease at which the operation is carried out. Archibald divides the condition into three stages, the first being purely bronchitic with no bronchographic changes; the second stage showing cylindrical and saccular dilatation, cough, and copious muco-purulent sputum, which on culture yields no anærobes, and the third or fetid stage characterized by quantities of foul-smelling sputum containing anærobes. Bronchograms reveal large bronchiectatic cavities.

The general use of bronchograms has facilitated the recognition of bronchiectasis before it has progressed to the fetid stage. Operation at this early period has lessened considerably the chances of a fatal empyema.

M. L. CONNELLY, M.D.

THE BRONCHI

Bronchostenosis: A Roentgenological Study. Nils Westermark. Acta Radiol., **19**, 285–312, September, 1938, and 313–336, October, 1938.

The author discusses the occurrence and course of bronchostenosis in different diseases of the lung and stresses the importance of bronchostenosis and its complications in radiological diagnosis.

Radiologically, bronchostenosis may be divided into three stages: Stage 1 with mild atelectasis and hyperemia as prevalent manifestations; Stage 2 with local emphysema and anemia, and Stage 3 with massive pulmonary collapse (obstructive atelectasis). These reported changes take place in the lung area corresponding to the stenosed or obstructed bronchus. A transitory stage occurs between Stages 1 and 2; this period is characterized by inspiratory atelectasis and expiratory emphysema.

Dependent on different stages and different phases of respiration, both the size and shape of the affected area may show marked changes in the roentgenogram. The outlines of the typical radiopaque wedge may become concave or convex; in advanced cases the affected areas may assume spherical shapes.

Bronchostenosis may be due to a large variety of causes which can be generally reduced to (1) changes in the lumen of the bronchus, (2) changes in the bronchial wall, and (3) changes outside the bronchus.

The article is well worth reading in the original.

ERNST A. SCHMIDT, M.D.

The Anatomy of the Bronchial Tree and its Clinical Application. J. Hardie Neil, W. Gilmour, F. J. Gwynne, Wallace Main, and W. A. Fairclough. Australian and New Zealand Jour. Surg., **8**, 118–131, October, 1938.

Although the secondary branching of the main bronchi is well known, few workers have studied the tertiary branches, considering the latter too inconstant for classification. The authors carried out a detailed study of the bronchial tree of various animals and numerous cadavers in which the material used included both metal casts of the bronchial tree and dissections of these structures, in specially fixed lungs. They found each third-order bronchiole to be the air supply for definite segments of lung tissue, which they mapped out. These anatomical units were designated as bronchopulmonary segments and were found to be constant in almost 100 per cent of the cases studied. Although their classification of these segments follows closely that of Kramer and Glass, they add one of their own discovery (subapical). They found that this division into such segments corresponds to the primary budding of the 9 mm. embryo's bronchi. The classification is as follows:

Upper Lobe: (1) apical (the segment usually involved in tuberculous infections); (2) anterior; (3) axillary; (4) paravertebral.

Middle Lobe: (5) anterior; (6) axillary.

Lower Lobe: (7) apical; (8) paravertebral; (9) posterolateral; (10) anterolateral; (11) mesial or cardiac; (12) subapical.

Confirmation of these findings was obtained by roentgenographic study of the chests of human subjects after 1 c.c. of lipiodol had been instilled into various of the above-designated third-order bronchi.

The clinical importance of this study is reflected in the localization of lung abscesses, foreign bodies, and bronchiectatic involvements. These segments appear to be the units of lung tissue, involved in these and other pathologic processes.

The authors also describe a procedure of bronchoclysis indicated in the treatment of bronchiectasis whereby merthiolate or metaphen, in 1:10,000 dilution in a saline isotonic solution, is introduced by catheter into the bronchiole of the involved segment of the lung. Increasing amounts of this solution from two progressing up to six ounces are introduced by a Murphy drip, at a rate of 30 drops a minute. The solution is absorbed by the peribronchial lymphatics and has a marked beneficial effect in sterilizing the bronchiectatic cavities and clearing up the perifocal areas of pneumonia.

SIMON POLLACK, M.D.

CALCULI

Differential Diagnosis of Biliary and Urinary Calculi. Henri Pons. Bull. et mém. Soc. de radiol. méd. de France, **26,** 421, 422, June, 1938.

By placing the patient on the table in the prone position and making two exposures on the same film, shifting the tube from left to right in the interval, it is possible to differentiate between biliary and urinary calculi by comparing the shift of the image of the calculus with that of the vertebral bodies. If the apparent shift is less than that of the vertebral bodies, the calculus is posterior to these bodies, and, consequently, in the urinary tract. If the shift is greater, the calculus is anterior and, therefore, in the biliary tract.

S. R. BEATTY, M.D.

Formation of Transparent Gas-filled Fissures in Gallstones, and Their Significance for the Radiological Diagnosis. Åke Åkerlund. Acta Radiol., **19,** 215–229, September, 1938.

Contrary to the common opinion that fissure formation is observed only in dried specimens of gallstones, the author points out that gallstones frequently exhibit this phenomenon *in vivo*. Usually these fissures are filled with fluid or semifluid material and do not provide any marked radiographic contrast to the body tissues. However, the fissures assume radiological significance in the rather rare cases in which they show unusual radiotranslucency or are able to alter the specific gravity of the concrement, which latter feature becomes apparent in roentgenological sedimentation examinations. In these instances, both the increased transparency and the low specific gravity of the calculi were due to the presence of gaseous substances in the fissures. For this gas-production, either gas-forming bacteria or other disintegration processes may be responsible. The specific gravity of the fresh specimens was estimated to range between 1.010 and 1.035, and lies, therefore, below the specific gravity of pure cholesterin. The fissures are, as a rule, star-shaped and may, in certain cases, facilitate the diagnosis of biliary calculi.

Note: In this connection, the abstractor wishes to point out the similarity between this phenomenon and the presence of gas in emphysematous cholecystitis in cases in which the gas formation is apparently due to the same causes. (For details, see his article on "Emphysematous Cholecystitis and Pericholecystitis." RADIOLOGY, **31,** 423–427, October, 1938.)

ERNST A. SCHMIDT, M.D

CANCER (DIAGNOSIS)

The "Romantic" Attributes of "Lawlessness" and "Malignancy" in Cancer. Horst Oertel. Am. Jour. Med. Sci., **197,** 1–7, January, 1939.

The so-called "lawlessness" and the malignant aggressive behavior of cancer are considered in this article.

The views that cancer cells are lawless, wild-growing, contrary to rules, and, hence, gangsters of the body, must renounce all intelligibility of cancer growth. It is a logical principle of all scientific inquiry that, in Nature, nothing occurs without a lawful causal chain, whether it fits into the normal causal scheme, or whether it lies outside of it. In the case of cancer, observations exist which point to a consistent and definite plan in the manner of growth.

In the gastro-intestinal tract, one may see the simple substitution of normal glandular epithelium by cancer cells which follow the normal architecture. Such simple substitution, an indication of intensity or tempo of growth, occurs in non-cancerous types as well. (It is only when these cells begin to reproduce that they break with the normal arrangement.)

The subsequent structural environment into which the cancerous tissue moves has a decided influence on its subsequent manner (differentiation) and intensity of growth; hence it is quite impossible to grade malignancy according to the type of cell occurring in a particular locality.

Metastases also show a normal sequence of structural development, except for the initial stage.

All these features of cancer growth may be reduced to the basic fact of intensity of growth.

The tumor cells, by virtue of their primary vascular or lymphatic position, have the first call on the nutritive material, permitting them to expand and encroach upon the wasting parenchyma. The so-called infiltrative (malignant) capacity is in reality only an intra-

canalicular vascular advance. Nowhere is there specific, direct aggression on parenchyma. Malignancy is, therefore, also reducible in terms of tempo of growth.

In order to arrive at a better understanding of cancer, the "romantic" ideas must be abandoned, and the subject treated as a problem of growth.

BENJAMIN COPLEMAN, M.D.

Primary Carcinoma of the Bronchus. Ira H. Lockwood. South. Med. Jour., **32,** 30–34, January, 1939.

Primary bronchial carcinoma comprises from 6 to 8 per cent of all carcinomas, and ranks next to malignancies of the gastro-intestinal tract in frequency.

It is characterized by a great variation in symptoms, which depend upon the location and size of the tumor, adjacent structures, and secondary changes. In 15 per cent of all cases, the primary tumor produces no signs or symptoms.

Any intrathoracic inflammatory condition which is unusually persistent should make one consider malignancy. An irritating, non-productive cough, a wheeze most marked at the end of expiration, and blood-streaked sputum are important symptoms.

Pain, dull or severe, constant or intermittent, may be the first symptom, and the author reports three cases in which the initial symptom is a low back pain.

JOHN M. MILES, M.D.

Early Diagnosis of Cancer of the Stomach. Louis J. Notkin. Canadian Med. Assn. Jour., **40,** 8–13, January, 1939.

Four cases of carcinoma of the stomach are reviewed, in which the x-ray diagnosis was made too late to be of service. Progressive changes in the films are demonstrated. The author believes radiologists should recognize early lesions as seen in the first examination or in repeat examinations done within reasonable periods. Diagnostic roentgen methods and criteria are very briefly discussed.

M. L. CONNELLY, M.D.

Carcinoma and Venous Thrombosis: The Frequency of Association of Carcinoma in the Body or Tail of the Pancreas with Multiple Venous Thrombosis. E. E. Sproul. Am. Jour. Cancer, **34,** 566–585, December, 1938.

The incidence of thrombosis in any portion of the circulatory system and the associated conditions were noted in a series of 4,258 consecutive necropsies. Carcinoma was found to be the most common cause of thrombosis of the neck, abdomen, pelvic veins, and extremities. Of 16 cases of carcinoma of body or tail of the pancreas, 56.2 per cent showed thrombosis and 31.3 per cent of these 16 cases showed widely disseminated venous thrombosis. Inflammation or invasion of these thrombosed vessels by tumor could not be demonstrated.

Carcinoma of the stomach was also associated with a high incidence of thrombus formation.

Other carcinomas were not associated with multiple thrombi, although single thrombi were reported in many cases.

The possible effect of interference with the blood-clotting mechanism by pancreatic activity is discussed. It is also suggested that achlorhydria associated with carcinoma of the stomach may alter the action of the pancreatic enzymes and thereby alter the coagulation of the blood.

The literature is thoroughly reviewed.

H. O. PETERSON, M.D.

The X-ray Diagnosis of Gastric Cancer. A. J. Delario. Jour. Med. Soc. New Jersey, **35,** 548–551, September, 1938.

A discussion of various roentgenologic types of gastric carcinoma is presented, stressing the diagnostic and therapeutic problems. The author advocates routine annual examinations especially for patients over 40 years of age. It is a short general treatment of the subject and contains no new material.

MAX MASS, M.D.